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Construction Difficulties of the Power Development at Tallulah Falls, Ga.

By J. B. Wier, Jr.*

The hydro-electric development of the Georgia Railway & Power Co., at Tallulah Falls, Ga., described in Engineering News, Jan. 29, 1914, presented many unique construction difficulties, on account of the character of the country. Here in the mountains of northeast Georgia is a miniature reproduction of the Grand Cañon of the Colorado—a gorge two miles long and from 100 to 800 ft. deep, carved out of a stratified rock. This stone, resembling coarse granite, in some places is very hard and in others is crumbling under the attack of weather. Through this chasm a mountain river flows in a series of falls and rapids.

Fig. 1. Lowering a 60-Ton Rotor at Tallulah Falls Plant

Readers of the previous article will recall that the works here comprise briefly a dam at the head of the gorge, a tunnel to carry the water around the edge to the lower end where it discharges into a surge tank from which five 5-ft. steel penstocks lead down the face of the cliff with varying grades up to as high as 150%, and at the foot of the cliff the power house where each penstock supplies an individual turbine, discharging back into the river bed.

The preliminary work was of unusual importance. In fact, the general difficulties here might be equally divided between (1) installation of construction equipment and (2) handling of materials as construction progressed.

Compressor Plant—On account of the difficulties of getting fuel to the scattered engines, it was thought best to supply all engines with compressed air, utilizing the energy of one of the falls. Water was carried from a temporary dam down a 7½-ft. penstock to a turbine driving two 2000-cu.ft. compressors; a 3-ft. penstock also led to a turbine which drove two 50-kw. generators for lighting the tunnel. A 10-in. trunk air line with takeoff feeders was run to all parts of the job. At the far end an 1800-cu.ft. steam-driven plant was later connected in for emergency use.

The main temporary compressor plant was situated at the foot of a 200-ft. vertical bluff and the place for it had to be blasted out of the foot of this cliff. Materials and men were transported to and from this job by means of an incline skidway about 250 ft. long and with a grade of about 110%. High waters of the ferocity and kind encountered only in such mountain streams greatly hindered the work and made it necessary to build a heavy bulkhead out into the stream to protect the completed compressor plant.

Main Dam—The dam presented no special difficulties. The site was excellent and the foundations solid. The stone quarry was below the concrete mixing plant, and both were below the dam site. A large steel derrick swung from the quarry to the mixing plant and a line of three ran between the latter and the far end of the dam site. There were several smaller wooden derricks in the quarry and about the site. No hauling of material was required.

A concrete bridge, supported on piers above the dam and taking the place of the old county-road bridge, had to be completed before the pond was filled. This also overtopped the bridge of the Tallulah Falls R.R. about 1½ miles above the dam and a new high-level span had to be built.

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TUNNEL—The entrance to the tunnel is just above the dam. This bore, approximately a mile and a half long, runs almost entirely through solid rock, and only in two places was timbering necessary. Work was going on simultaneously from both ends of the tunnel as well as from three adits leading to the face of the cañon and in two directions from one shaft. While the character of the rock varied, it was in the main the coarse granite. Great difficulty was experienced in getting a proper temper on the drills and, on account of the hard-cutting quality of the rock, the gages of the steel had to be changed about twice as often as usual.

Several methods of driving the tunnel were tried, to suit the various conditions, such as quality of rock encountered, etc. In some places, top headings were driven first and later the bench headings; in other places the bottom headings were first made and later the upper face was shot down upon a tramway built into the tunnel as the top heading progressed. In two places, decomposed rock with water greatly hindered progress and heavy timbering was needed. In all places, the hard rock and its cracks and seams made drilling difficult.

FIG. 2. TEMPORARY COMPRESSOR PLANT

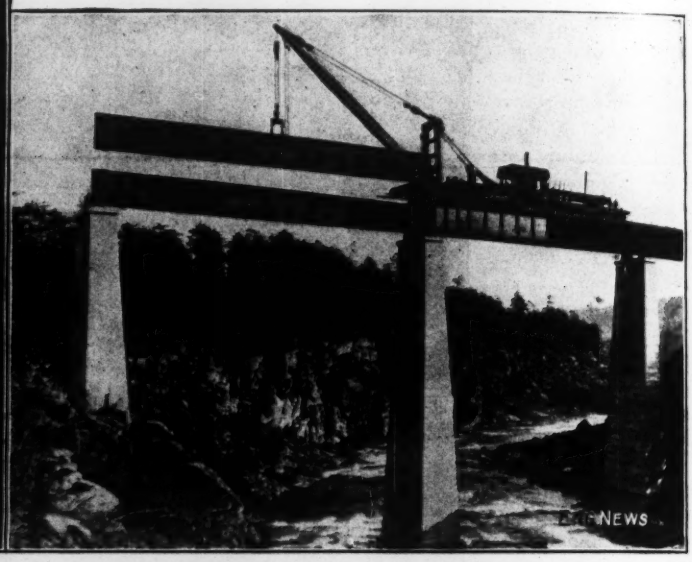


FIG. 3. NEW BRIDGE FOR TALLULAH FALLS R.R.

The tunnel was lined with a minimum thickness of 18 in. of concrete. Crushed stone was secured from independent crushing plants at each entrance to the tunnel. Stone taken from the tunnel had been crushed and stored at these entrances, so that there would be no delay when concreting began. The concrete was placed with MacMichael's pneumatic mixers, being conveyed in a pipe for a maximum distance of 800 ft. to collapsible steel forms. These were in 40-ft. lengths. Spiral riveted pipe was used at first on account of its light weight. However, the rivet heads tended to impede the flow of concrete and rapidly wore off. This led to blowouts which interrupted work. In one case a pipe blew out when a workman was close by and resulted in the l[illegible] of his eyesight. A light welded-steel pipe was subst[illegible]

The forebay or surge tank was excavated at [illegible] lower end of the tunnel, but on account of the infer[illegible]uality of rock toward the cliff side, the walls were r[illegible] sides of a heavy cross-tied steel cage embedded in t[illegible] concrete which, structurally, served only to tran[illegible] pressure stress to the steel. The concrete was pl[illegible] with movable chutes, leading from a stationary mix[illegible] plant at the top. The steel was lowered by the same [illegible]rricks which raised the excavation.

INCLINED RAILWAY—From a platform just to [illegible] side of the forebay, an inclined railroad was built pa[illegible]lleling the penstocks and terminating at the power house. This incline was built on grades running from 43% to 100%. A 60-ton (capacity) steel car was operated on this incline by a hoist at the top, equipped for using steam, compressed air or electricity. On this incline all materials, equipment and men, had to be handled for all work below, as it was barely possible to climb up the face of the gorge. The lowering of heavy and awkwardly shaped pieces of machinery required special care and skill. The heaviest single pieces hauled in this way were the rotors of the generators, weighing about 60 tons. Many extremely awkward pieces had to be handled, such as crane girders, steel building columns, top-heavy transformers, etc. It is gratifying to state, however, that no serious mishap occurred.

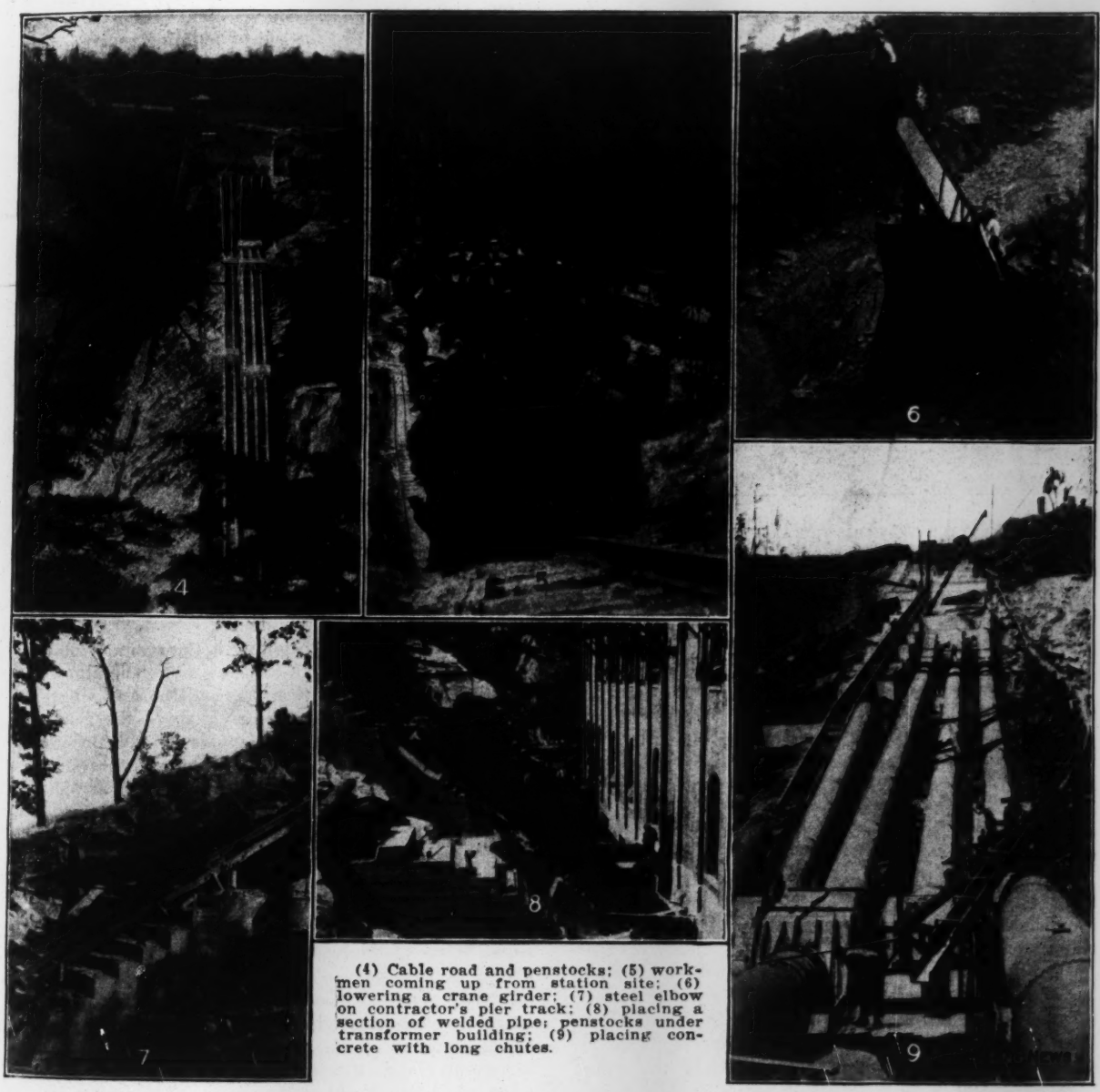
PENSTOCK AND POWER-HOUSE EXCAVATION—The excavation on the runs for the penstocks and the excavation for the buildings at the power house was carried on by derricks, and the only really serious difficulty met with was the fact that it was impossible to keep stone from rolling from the penstock runs down upon the power-house site. Regardless of how careful they might be, frequently stones from 8-yd. size down, would get loose at the top and, with a start of 1000 ft. or more down a 100% grade, would play havoc with the work and equipment lower down. One might ask why the work was not started at the top and completed as it was carried down but, as is usual with work of such magnitude, time was

the gr... consideration and the work had to be carried on sim... aneously at several points.

To ... inimize this danger, a large bulkhead was constructe... of timber and stone across a depression or pocket, about 200 ft. above the power-house site. This caught ... large part of the stone, and acted as a safeguard to thos... working below. This bulkhead had afterward to be rem...ved as it was in the way of the penstock pipe lines. As an added precaution, no blasting was allowed on the hillside until after working hours, and after all men had left from below.

PENSTOCK PIERS—The penstocks were carried on concrete piers with heavy anchor-blocks wherever there was a change of grade. The concrete for these piers and blocks was placed by means of chutes placed at intervals along the hillside. Concrete in this manner was satisfactorily conveyed a maximum distance of 700 ft. As the distances became greater, "relay stations," consisting of a large hopper, were introduced. If the aggregate and grout became separated, as it often did, these stations acted as a check to such action; at the place of deposit it was thoroughly spaded and if necessary remixed by hand as it went into the forms. Concrete placed thus was found to be very satisfactory and, contrary to the expectation of some, showed uniform texture.

LAYING PENSTOCKS—The steel penstock pipes were laid from the bottom up. The lengths were handled by a system of small derricks which were moved up hill as the work progressed. One derrick was always kept within reach of the incline-road car; this loaded the pipe to a small truck running on a wood skidway running down the line of piers, as shown in the accompanying figures.



(4) Cable road and penstocks; (5) workmen coming up from station site; (6) lowering a crane girder; (7) steel elbow on contractor's pier track; (8) placing a section of welded pipe; penstocks under transformer building; (9) placing concrete with long chutes.

FIGS. 4-9. VIEWS OF CONSTRUCTION WORK AT TALLULAH FALLS

A second derrick lifted the pipe into place and held it while a few bolts were slipped into rivet holes. The length of pipe was then blocked up and accurately lined by jacks while the joint was finished. The pipe came fabricated in 32-ft. lengths and these were joined with a double row of field rivets. On account of the steepness of the grades on which the pipe was placed in some places, some difficulty was experienced in holding the sections together until they had been riveted and concreted in place. As there was an expansion joint in the pipe at each change of grade, just below the anchor blocks, it was found absolutely necessary to concrete the anchor blocks around the pipes before many sections of pipe could be placed above them, or else the weight of the pipe itself would cause it to slide down hill. Struts and braces were also used to protect against sliding.

Much of the pipe was placed during the summer months and the sun, which had a clean sweep of the hill for practically the entire day, made the inside of the pipes almost unbearably hot. This was especially troublesome as the completed length of penstock became longer and acted more and more like a tall chimney. The rising air

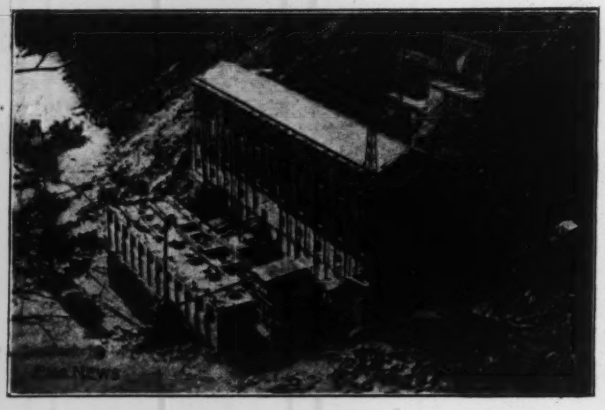


FIG. 10. PARTIALLY COMPLETED POWER STATION, SHOWING LACK OF STORAGE FACILITIES

left the upper end at a temperature of about 140°, and blowing at a fair rate of speed. If the lower end of the pipe was closed, conditions became even worse, as the air then became close and stifling. Riveting gangs could not be kept for any length of time inside the pipe, and there were some instances even of their being overcome. To increase the rate of progress on the pipes, the work was arranged so that all placing was done in the daytime and the joints left ready for final riveting at night. Electric lights were furnished for this. The riveting itself was done considerably faster in the night-time as the pipe was cooler.

POWER-HOUSE CONSTRUCTION—The plant at the foot of the cliff consisted of two buildings—a power house approximately 50x200 ft. and just behind it a transformer and switch house 50x250. The main difficulty experienced in excavation was the waste of muck and the storing of stone for concrete. The cliff slope which flattened to some slight extent at the river was still entirely too steep to store material on, while the opposite side presented only a vertical bluff running from the water's edge about 200 ft. high before it began to slope back at all. This difficulty was overcome to some degree by encroaching on the river bed in a comparatively [illegible] place, at the upstream end of the site, just enough to [illegible] footing, and then banking the stone up against [illegible] hillside.

The rock here was stratified, varying from [illegible] remely hard to very soft and rotten. It was full of [illegible] and seams; and in addition sloped downward in [illegible] directions—about 22° downstream, and about 8° [illegible] to the river. After going into the rock for some dist[illegible], however, good foundation was reached where the act[illegible] of the weather had had no effect on the stone.

One of the greatest troubles encountered was [illegible] record high waters which came during construction. On account of the narrowness of the gorge, the waters rose rapidly and traveled at a tremendous rate. Their carrying power was almost beyond belief—they easily swept 4- and 5-yd. stones down the river bed. The destruction of coffer-dams was a source of much delay.

The two buildings had concrete foundations (brick and steel superstructure); instead of building separate foundations for the different machines, the power-house building foundation was solid masonry with draft tubes and drains set in it. The amount of concrete for these buildings, therefore, was large but it was successfully handled by the same system of derricks which had taken out the excavation. A crushing and mixing plant was placed at one end of the site, and this plant was within reach of two derricks.

On account of the longer time required to install the electrical apparatus in the switch and transformer house, construction on this building was carried on ahead of the power-house building. The erection of steel was started with the same derricks which had been handling concrete. These derricks carried this work on until the superstructure got out of their reach, when smaller rigging was installed and carried up with the building.

About this time, the lack of storage facilities at the power site was felt most. All material had to be unloaded and stored along a spur track which ended at the head of the incline road. It then had to be reloaded, hauled to the incline, loaded on that, and then lowered to the power house, where it had to be unloaded again. Obviously, material could be carried thus only in quantities which could be quickly used. The incline was run night and day.

One feature worth mentioning is the accuracy obtained in the setting of the wheel cases and generator bases. The units are of the vertical type, all the revolving parts being carried on a thrust bearing above the generator. This bearing is supported by a spider which transmits the load to the generator housing which in turn rests on a base set in the concrete floor. This load is carried by a heavy steel-girder system embedded in concrete, and spanning the wheel room. The allowable limit of variation in setting these wheel cases and generator bases was 0.0005 ft.

The plant is now in successful operation, and besides being on account of its locality, one of the most picturesque, is one of the most modern and efficiently arranged plants in existence. The entire development was designed by Chas. O. Lenz, of New York City, as Chief Engineer of the Georgia Railway and Power Co., and as Chief Engineer of the Northern Contracting Co., which carried on the construction. Direct supervision was under Chas. G. Adsit, Resident Engineer. The writer was in charge of the Penstock and Power House Division.

Design and Construction of Earth Roads in Iowa

By T. R. Agg*

SYNOPSIS—*The Iowa State Highway Commission has jurisdiction over all the town and county roads of the state, and it has given particular attention to improving ordinary earth roads, which interlace one of the richest agricultural districts in the United States. The cross-sections adopted for these roads are illustrated and explained, the limiting grades are given together with recommendations for alignment at railway grade crossings and on curves. The use of the elevating grader is explained, and the cost of road work done by this machine and equipment in Iowa is given.*

The design and construction of earth roads present many problems, particularly in those states where a large amount of earth road construction remains to be done before hard surfacing can be taken up on an extensive scale; for the earth road should be designed to provide

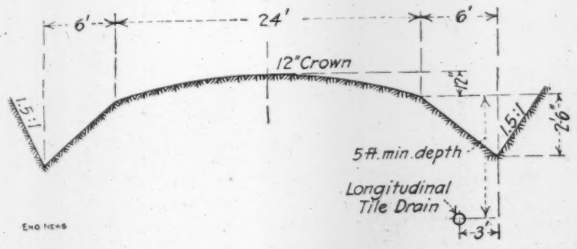


Fig. 1. Cross-Section for Earth Roads Having Grades of 2% or Less

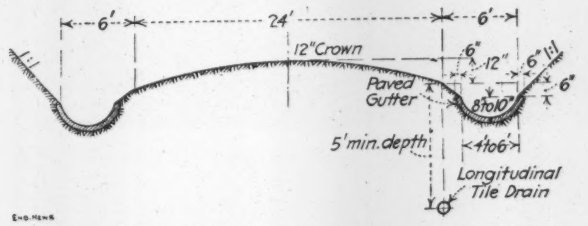


Fig. 3. Cross-Section for Earth Roads Having Grades of 4% or More

for future hard surfacing, as well as to accommodate present traffic. At the same time, the design should be such as to be readily constructed with the elevating grader, or other commonly used earth-working machinery. The design may vary somewhat in different communities, but there are certain clearly defined principles that may be applied in the states of the Middle West.

Cross-Section

Crown—Ample side ditches are necessary for removing rainfall and water from melting snow. The amount of slope that can be given to the cross-section of the traveled way is limited by considerations of the safety and comfort of those who travel the road, and experience not exceed about 1 in. per foot. When the circular arc cross-section is used, the slope increases from the middle of the road to the ditch line, as is proper. It has frequently been stated that the cross slope should be greater on hills than on the level, and while that is desirable from the standpoint of drainage, it is exceedingly undesirable from the standpoint of safety, whether the traffic be made up of motor vehicles or horse-drawn vehicles. The tendency to slide is greater on hillsides than on the level, and the results of skidding or sliding to the ditch, much more aggravating.

Width of Traveled Way—For slow moving vehicles a comparatively narrow track is all that is necessary, but for mixed traffic, a part of which moves at relatively high speed, plenty of room is desirable; and such traffic is encountered on most of our country roads. For first-class roads the traveled way should not be less than 24 ft. wide indicates that if the entire cross-section between the

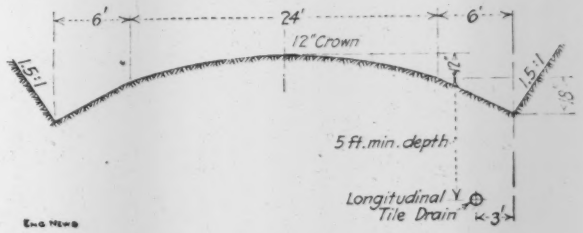


Fig. 2. Cross-Section for Earth Roads Having Grades Over 2% but Less than 4%

ditches is to be available for traffic, the cross slope must and for secondary roads, not less than 20 ft. wide. This much of the roadway should have a circular arc cross-section with a crown of an average of 1 in. per foot from the center line to the shoulder line.

Ditches—Beyond the shoulder line the ditch should have a width great enough to give an easy slope from the shoulder line to the bottom of the ditch. Safety demands that this slope be such that in an emergency a vehicle might turn out into the ditch without danger of overturning. The minimum width of ditch should be about 6 ft., with a back slope of 1½ on 1, but with some soils it may be 1 on 1, or as steep as the soil will stand.

Besides fulfilling the considerations before mentioned, the type of cross-section adopted should be one that can be readily constructed with ordinary earth-working machinery. For that reason, the V-section should be used for the ditch rather than the trapezoidal section.

The rate of grade at which it is desirable to change the size of ditch is a matter of judgment and experience, but it is believed that for grades up to 2% there should be little change, particularly if there is any snowfall to be considered. Above 2% the ditch may be of somewhat less capacity than for lighter grades.

A still further reduction in the ditch capacity may be made at about the grade where erosion begins; and usually for permanent construction the ditch is paved, or erosion prevented by lateral dams or check weirs such

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as used in irrigation ditches. Erosion usually begins with grades of about 4%, although this is exceedingly variable, dependent upon the type of soil.

IOWA STANDARDS—The cross-sections used by the Iowa Highway Commission are shown in Figs. 1, 2 and 3, and illustrate the general application of the principles enumerated above.

Finally, the cross-section should be so designed that when the road is surfaced with macadam, concrete, brick, or other hard material, no great amount of earthwork will be necessary to prepare the earth foundation for the hard surface. It is desirable to have a little excess crown in the earth road so that by the time enough material has been removed to true up the foundation the crown will have been reduced to the proper amount for the hard surface.

PROFILES

One of the most troublesome problems in the design of earth roads is encountered when the grade line is being established. Where existing grades exceed 3% (and they are often as great as 5 or 6%) it is usually not difficult to determine just how much to change grades, and the official with whom the engineer must deal will agree to almost any reasonable change. But in rolling country the profile of the road is a succession of knolls with none of the grades exceeding 2 or 3%, and it is often difficult to convince non-technical boards that any change in the profile of such a road is economical.

On such roads the difference in elevation between the two ends of a mile of road may be only a few feet, yet a vehicle may have traveled a vertical distance of four or five times that amount in the mile. If any saving in this latter expenditure of energy can be made it is a saving which goes on for all time; and a community could more rationally issue long-term bonds for grade reduction than for any other form of road improvement.

LIMITING GRADES—The maximum grade should not exceed 4%, but in exceptional cases it may be as great as 6%. If a grade of 6% or less cannot be secured, the possibility of relocation should be investigated and if feasible, a recommendation for relocation should be made.

ALIGNMENT—If a grade of 3% or greater is more than 400 ft. long, there should be a level section 25 ft. long introduced at approximately the half-way point. If there is a deflection of more than 60° in alignment on a grade of 3% or greater, considerations of safety demand that the grade line be made level for the length of the curve.

GRADE CROSSINGS—At railroad crossings the grade line should be a straight line across rail heads for 30 ft. on each side of the middle of the track, and should be connected with the grade line beyond by suitable curves.

VERTICAL CURVES—At breaks in the grade line the transition should be made by means of a circular arc, tangent to the two sections of grade line and having a length in feet of approximately 25 times the algebraic difference in grade of the two sections.

GRADE REDUCTION—It is desirable to reduce the total vertical rise to as low an amount per mile as practical.

FIG. 4. USING AN ELEVATING GRADER AS A LOADER IN GRADE-REDUCTION WORK. STONY COUNTY, IOWA

As a guide it may be assumed that it pays to move from 100 to 150 cu.yd. of earth to make a reduction in grade amounting to 1 ft. per mile. This allowance may be increased if heavy grading is necessary on a part of the mile to bring the profile to the limiting grade. Short, sharp undulations in the grade line should be eliminated as far as possible.

Safety should be an important consideration and a clear view should always be possible at a distance of at least 250 ft. Any grade line that precludes this should be revised.

USE OF THE ELEVATING GRADER

If a road is designed in accordance with the above principles, particularly as regards cross-sections, the elevating grader can be used to good advantage in the construction.

In general, the work to be done consists in rounding up the traveled portion of the road with material obtained from the side ditches. The best results will be ob-

FIG. 5. CONSTRUCTION OF EARTH ROADS WITH ELEVATING GRADER, POTTAWATTAMIE COUNTY, IOWA

tained in flat country or slightly rolling country, where sections of a mile or more in length can be constructed at one time, thus obviating frequent turning of the outfit.

CLASSES OF ROAD WORK FOR ELEVATING GRADER—There are the three following classes of roads encountered in the various counties in Iowa where the elevating grader has proven satisfactory:

(1) Roads practically level where the new grade line is parallel to the profile on the old road, there being only a few knolls to be removed.

(2) Roads on which there are a succession of knolls and consequently a succession of cuts and fills most of which do not exceed about 2 ft. in depth.

(3) Roads where extensive grade-reduction work must be done.

GRADER OUTFITS—The outfit necessary for roads of Class 1, consists of the elevating grader drawn by 6 or 8 teams or by a tractor, a blade grader, a few slips or wheelers, a heavy disk harrow, a heavy straight-tooth harrow, and a split log or plank drag. If a roller is also available a better road can be constructed than is possible

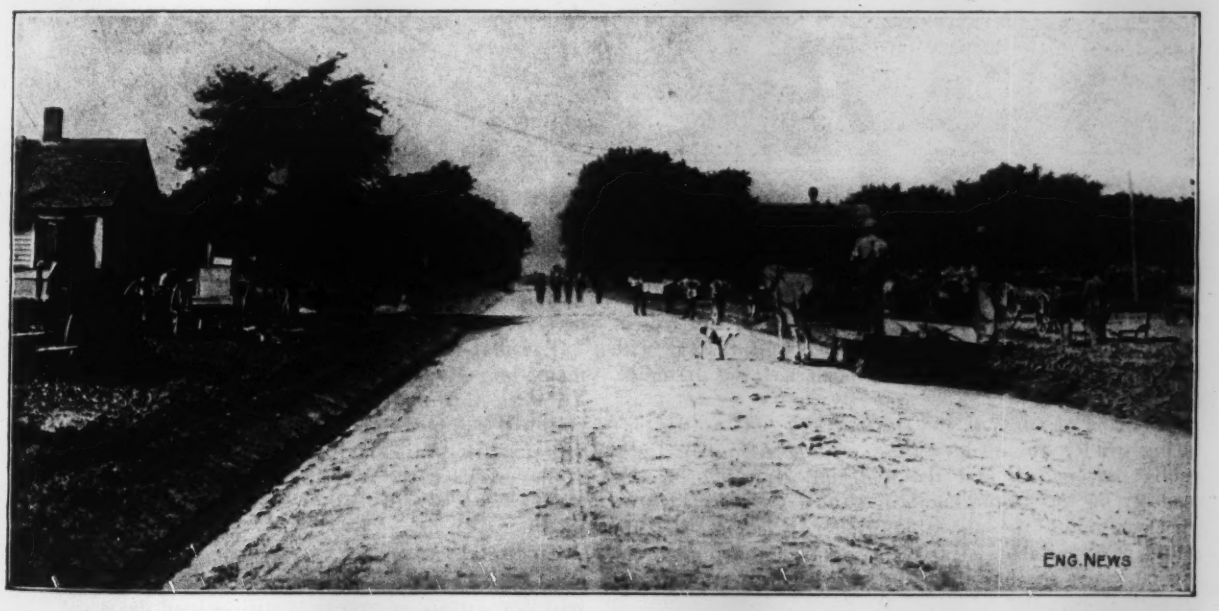


FIG. 6. ROLLING A ROAD BUILT WITH ELEVATING GRADER, POTTAWATTAMIE COUNTY, IOWA

without it. For roads of Classes 2 and 3, a number of dump wagons are also necessary.

CONSTRUCTION METHODS—In starting the construction the first cut is taken at the shoulder line, and the material thus removed is deposited near the shoulder line of the opposite side of the road, but, of course, in the roadway.

Stakes are set for the first cut so that the driver can follow them conveniently. If the outfit is horse-drawn, the stakes are set so that the tongue of the elevating grader will follow them. If the grader is drawn by a tractor, they are set so that the front wheel on the steering side will follow them. The exact distance of these stakes from the line of the cut will vary somewhat with the type of elevating grader used and must be determined before the stakes are set.

The first cut is a light one and usually one horse of the elevating grader, loading where cuts are [illegible] made and dumping the materials in the fills, [illegible] evating grader continuing its rounds and depositing [illegible] tly on the road in the low places. Here again a [illegible] ide adjustment of working forces must be made so [illegible] the elevating grader will not have to wait on the [illegible] ns. It is more economical, however, to construct a [illegible] or more of road at a time than it is to turn the elevat[illegible] grader constantly, as would be necessary if each cut [illegible] e completed by itself.

On roads of Class 3, the elevating grader [illegible] simply used as a loader for the wagons, and each cut [illegible] is completed by itself. The economy of the grader in this case depends upon the steepness of the grade and the room for maneuvering.

As the elevating grader makes successive rounds it gets farther away from the center of the road and, consequently, when it is at the deepest part of the ditch where the heaviest cutting is being done the earth is deposited in the middle of the road, where the greatest filling is necessary to give the crown.

FIG. 7. COMPLETED ROAD, POTTAWATTAMIE COUNTY, IOWA, BUILT WITH ELEVATING GRADER

the lead team follows this first furrow and thereby guides the grader in making the succeeding cut. If the grader is drawn by a tractor, a side hitch is used so that the tractor travels on the "land" side, and a plumb bob is hung from the tractor in such a position that it will follow the furrow and thus serve to assist the driver in steering.

On roads of Class 1, the successive rounds of the elevating grader are made without reference to the slight knolls that occur; and the material deposited on the roadway on top of the knolls is hauled away by slips or wheelers, while the elevating grader is completing its round. A suitable adjustment of the working forces can be made so that the slips or wheelers can be kept up with the grader.

On roads of Class 2, teams with dump-wagons follow

The material deposited on the roadway will consist of many large lumps as well as of sods and fine material. To work this material down to a surface that can be traveled, the clods and sods must be broken up with a disk harrow until small enough to form a satisfactory surface. Often the sods and weeds are collected by harrowing with a stiff-tooth harrow and thrown out with pitchforks.

To bring the surface to its final shape a few rounds must be made with a blade grader. Then, after the first rain, the surface is smoothed with a road drag and when partially dry, rolled. Constant dragging is necessary

during the first year to keep the road in shape, while it is becoming compacted by traffic.

COST DATA—The cost of constructing earth roads by this method varies from about $100 per mile for Class 1 roads, to $250 per mile for Class 2; while the cost of Class 3 is an exceedingly variable quantity, as is apparent from the nature of the work. As an average of the work done by some of the well organized counties $150 per mile may be taken.

The cost of the elevating grader outfit is from $4000 to $5000, depending upon its size and the number of accessories used. To secure economical construction requires experienced supervision and proper working conditions, but when these are had, the use of the elevating grader is one of the most economical methods of earth-road construction. In general, it is not suitable for any unit smaller than a county, because of the cost of the outfit and the mileage of work that must be done yearly to make it pay.

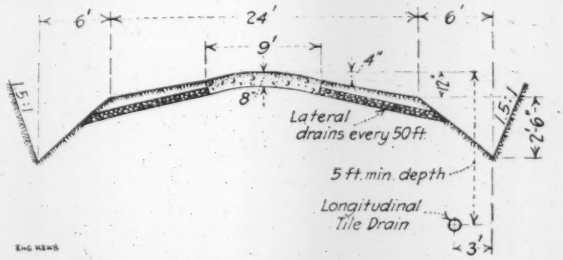


FIG. 8. CROSS-SECTION FOR MACADAM ROADS, RECOMMENDED BY IOWA HIGHWAY COMMISSION

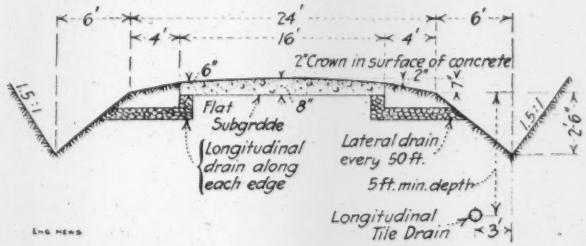


FIG 10. CROSS-SECTION FOR CONCRETE ROADS, DOUBLE TRACK, RECOMMENDED BY IOWA HIGHWAY COMMISSION

CROSS-SECTIONS OF PAVED ROADS

Figs. 8, 9 and 10 show cross-sections recommended by the Iowa State Highway Commission for earth roads with pavement surfaces of macadam and concrete. A comparison of these cross-sections with Figs. 1, 2 and 3 will readily illustrate how the earth roads are designed and constructed in such a manner as to be suitable for hard surfacing without radical changes, or reconstruction.

Canadian Government Expenditures on Railways and Canals in the fiscal year ending March 31, 1913, amounted to $36,689,539, according to the annual report just issued. Of this amount $13,167,000 was spent on the National Transcontinental Ry., $1,099,000 on the Hudson Bay Railway and $1,512,825 on the Quebec Bridge. The expenditure on canals was $3,853,000. The total Government expenditures on railways amounts on capital account to $304,015,587. In addition there has been expended a total of $244,071,325, covering the operating expenses of the Government roads and $48,529,915 subsidies other than the $25,000,000 granted to the C. P. R. for its main line, making a grand total of $548,086,913

Success of the Engineers' Register of the Junior Institution of Engineers

Since the publication of the editorial in our issue of Aug. 21, 1913, in which was described the work done by the Junior Institution of Engineers, of Great Britain, in helping its members to better positions, we have received several inquiries for further information, and have noted from the proceedings of engineering societies in this country a widespread interest in the results accomplished by the Junior Institution's Engineers' Register. The following facts in regard to the success of the Engineers' Register are taken from the March *Journal* of the Institution:

Naturally, when organizing such a scheme as the Engineers' Register, there is a tremendous amount of spade work to be done, and it has only been the hearty and loyal coöperation of the members that has enabled the Council to fill over 60% of the positions notified as vacant, the remaining 40% not being filled, as the list of members available for these positions had been exhausted, so it becomes obvious that the register is not all "forms" and no results, as perhaps some members may think, but on the other hand, the great difficulty is to find members suitable for vacancies which are notified.

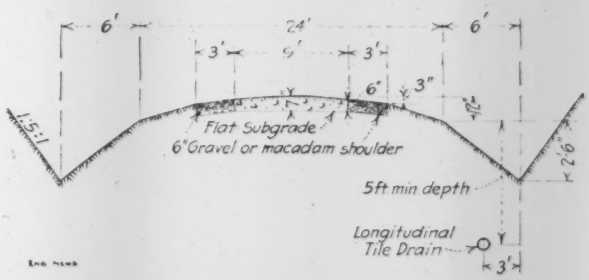


FIG. 9. CROSS-SECTION FOR CONCRETE ROADS, SINGLE TRACK WITH GRAVEL OR MACADAM SHOULDERS

In an institution with a membership representing so many branches of the profession, one would have thought it possible to find a candidate for almost all classes of work, but owing perhaps to pressure of work at the moment, or other reasons, the greater proportion of the members have not returned their forms, and, therefore, the Secretary has been unable to get into touch with men with suitable qualifications. Looking through the list of vacancies for the past few weeks, one finds all branches represented, and salaries offered ranging from $325 to $2500 per annum. The Council will not consider that the scheme has been completed until every member has filled in and returned his form, so that it may become a unit in an organization which will help to support the profession of engineering on the high pedestal on which it rests.

The Council cannot be expected to do everything, and members should assist them by advising the Secretary of any appointments they know to be vacant. The Secretary can then apply to the firm in question and bring the Register to that firm's notice. (The name of the member who notified the vacancy will not be mentioned unless he gives permission.) There is undoubtedly a great spirit of "camaraderie" among members of the "Juniors," therefore, why not increase that feeling in a practical way by assisting less fortunate members to improve their prospects in life. Without in any way becoming a trade union, we have a great opportunity before us in helping each other to find employment suited to our qualifications and experience.

It might be added that engineering employment problems have reached a far more acute stage in England than in this country. Some idea of the keenness of competition and the overcrowded condition of the engineering profession in Great Britain may be had by reading the book, "Engineering as a Profession," a review of which was published in our issue of Mar. 19, p. 645.

Converting a Tunnel into an Open Cut; Southern Pacific Ry.

By George W. Wade*

Early in 1910, repair work was in progress in tunnel No. 10 of the Southern Pacific Co. (Coast Division), the work being the enlarging and retimbering of the tunnel preparatory to putting in a concrete lining. This tunnel was 267 ft. long, situated on the Cuesta grade, 240 miles south of San Francisco.

On Feb. 23, the tunnel section had been enlarged and the new timbers placed for a distance of 45 ft. in the east end; the old timber portal had been removed and was about to be replaced by a standard concrete portal. Much trouble had been experienced during the progress of the work by the breaking of the timbers (both old and new) by the terrific side squeeze. About midnight, the timbers gave way, a cave-in occurred, and 42 ft. of the bore became absolutely closed.

Fig. 1. Tunnel No. 10, Southern Pacific Ry. (Coast Division), the Day Before Its Collapse

Division officials were on the ground early the next day, and as soon as extra tunnel gangs could be assembled, an attempt was made to drift through the cave-in. The method followed consisted of erecting square sets and the driving of lagging to support the earth so that the tunnel section could be excavated. This work was pushed forward as rapidly as possible, and by noon of Feb. 26, six sets of timbers (2ft. c. to c.) had been placed, leaving a distance of 33 ft. between breast boards. The new timbers, however, showed signs of failure; some had already been replaced, others were bowing and kicking out at the bottom, and at a conference of officials, it was decided to abandon the attempt to reopen the caved-in portion.

On account of the sliding tendencies of the shale formation and the poor success made of supporting it with timber, and in view of the fact that the tunnel was short (267 ft.), it was decided to convert it into an open cut. The plan adopted was to burn out the remaining timbers and allow the entire tunnel to cave in, so that steam shovels could handle the material advantageously. Cross sections taken on the basis of a 20-ft. roadbed and slopes of 1 on 1, indicated that there was a total of 33,700 cu. yd. of material to be excavated.

A small gang of men was put to work on a drift about 2 ft. square, along the roof line, through the cave-in, this hole being deemed necessary as a draftway. The track was cut at each portal to allow expansion in the rails and the exposed rails in the tunnel were covered with earth to protect them from the heat. Several cans of coal oil and crude oil were used in splashing the remaining timbers, and cotton waste saturated with oil was distributed at about 5 ft. intervals among the timbers. A space of about 50 ft. from the draftway was left unoiled in order to delay (if possible) its burning and the consequent caving and shutting off of the draft.

At midnight, Feb. 26, a torch was applied and very soon the entire tunnel was a mass of flames, the draft being westward. At 12:57, the first few timbers fell, about 150 ft. from the west portal; others followed within a few seconds and at 1:08 a.m., the tunnel had caved in for its entire length.

Two 70-ton steam shovels arrived early the following morning and preparations were at once begun to set them to work. On the east end, it was possible to move the shovel to the face at once, but on the west end, about 1800 cu.yd. of a side cut had to be removed to make room for a loading track parallel with the main line. The shovel on the east end started operations Feb. 27, the one on the west end started Mar. 1.

The working system was the reverse of that ordinarily followed in steam-shovel work. The shovel was alternately pushed to the face by a locomotive and withdrawn to dump its dipper load into cars on a parallel track. A crew of six pitmen kept the track clear ahead of the shovel and handled the blocking for the jack-arm whenever it was necessary to swing the boom to the side. Between the main line on which the steam shovel traveled and the loading track, a permanent jack-arm rest was arranged by interlocking three rails (the center one inverted) and supporting them on blocking. This arrangement made it possible for the steam shovel to swing the boom and dump the dipper into cars at any point within the length of the train.

Three 12-yd. air-dump cars were handled on the loading track at one time, with engine attached, while three more empty cars with engine stood ready to move in as soon as the loads were pulled out. The system was identical at both ends of the tunnel and tracks were laid with crossovers, etc., to facilitate train movements. There were always three, and sometime four, engines working at each end. It was estimated that there were 3000 train movements daily at each end. The dumping ground was close at hand, making the hauling distance about 700 ft. The grade is 2.20% at each end, with 6° curves.

When the shovels had cut into the hill a distance of about 50 ft., small slides from the sides began to come down, causing delay and adding to the amount of material to be handled. These slides increased in size and frequency as the shovels approached each other and, when the job was completed, the final cross-sections indicated that there had been a total of 65,000 cu.yd. of material excavated. The final roadbed was 50 ft. wide.

During the first day of the trouble, a suitable trail 1000 ft. in length was benched around the hill, over which the passengers from one train daily each way walked; the baggage, mail, express, etc., was transferred on trucks. The average time consumed in transferring between these trains was one hour.

Ideal weather conditions with attractive mountain scenery afforded pleasure rather than hardship to passengers and the work attracted many curiosity seekers

*Herald Hotel, San Francisco, Calif. (formerly assistant engineer, Southern Pacific Co.).

and railroad men from other divisions and systems made visits of inspection.

The work proved to be an unusual opportunity for testing the efficiency of men and machinery. In addition to the two 70-ton shovels ordinarily engaged, two smaller ones were kept under steam ready to substitute in case of a breakdown. Aside from an occasional broken axle or U-bolt, very little shovel trouble was experienced considering the unusual manner in which the shovels were operated. Considerable rivalry developed between the crews at the opposite ends as well as between the day and night forces and the work soon assumed the nature of a contest. Men became enthused with the spirit of competition and the idea of wages seemed for a period to be forgotten. With all the rush and excitement during the 16 days of strenuous endeavor, but three men out of 200 odd men employed were injured. Normal traffic was resumed on Mar. 12.

During the progress of the work, the camp, known as "Owlville," had much of the dignity of a small village, with a water and sewer system, electric lights, police service, commissaries, all-hour dining rooms, etc. Also, two issues of a miniature newspaper, *The Owlville Sporting News*, devoted to joshes and jokes on officials and employees, made their appearance. The original sheet was mimeographed in a private car and later, the demand for copies becoming too great, was printed and the issues are now held as valuable souvenirs.

The actual cost of the work totaled $47,220, or 72½c. per cu.yd. of material handled. The banner day's work was performed on Mar. 6, when a total of 150 cars of 12 yd. each, or 1800 yd., was loaded and dumped in 8 hr. 18 min., net working time. In doing this, the steam shovel traveled an approximate distance of 180 ft. (2 × 90) for each dipper load. The average time consumed per dipper load was 54 sec. The average loading time per train of three cars at 12 yd. each was 8 min.

The enginemen of the locomotives handling the steam shovels in and out of the cut became so expert that the reverses were made practically without a stop. The steam-shovel crew became so proficient that the boom was swung and the dipper raised and lowered, virtually, on the fly. As far as the writer can ascertain, this was the most extensive work ever performed by this method in the West. Also, the record of 1800 yd. in one day ranks foremost in steam-shovel records.

FIG. 2. EXCAVATING OPEN CUT ON THE LINE OF THE COLLAPSED TUNNEL

FIG. 3. THE COMPLETED CUT ON THE LINE OF THE ORIGINAL TUNNEL

Rail Breakages and Track Wave Motion in Cold Weather

The wave motion of track under a moving train is a well known condition, and a correspondent recently inquired as to the relation of this movement to rail breakages, especially in cold weather when the steel is more brittle and less able to follow the wave motion. In this inquiry, however, the fact is overlooked that the roadbed is more rigid in cold weather, with consequent reduction in the wave-motion effect.

It has been pointed out by Robert Trimble (Chief Engineer of Maintenance-of-Way, Pennsylvania Lines) that it is a well known fact that steel is more brittle and more liable to fracture in very cold weather than in warm weather. In cold weather, also, the roadbed is more rigid, and greater stress is likely to be thrown on the rail owing to the rigidity of some of the supports, which tends to increase the span of the rail (between supports) beyond the normal spacing of the ties. The passage of every wheel causes rapid reversal of stress in the rail, independent of any wave motion of the roadbed and track. In very cold weather, the change in physical condition of the steel probably renders the rail less able to adjust itself to these rapid changes in stress.

It is stated also by P. H. Dudley, Consulting Engineer of the New York Central Lines, that few rails are broken by bending of the rail in front of the truck wheel, which is the bending due to the wave motion of the track and roadbed as a whole. The breakages are caused more largely by the bending of the rails between the wheels due to the reversals of stress noted above.

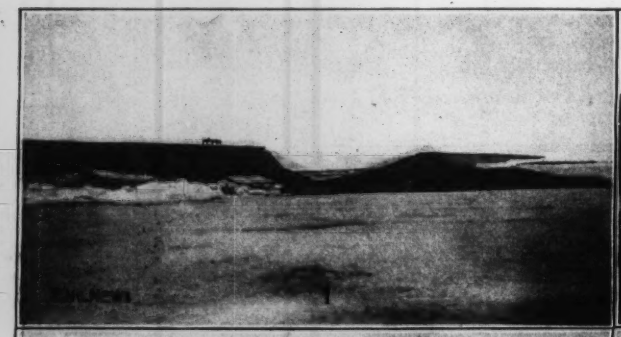
As to the condition of the rail steel, he states that the bessemer steel in cold weather has a slightly higher modulus of elasticity, and while it will bend in temperatures of 20 to 30° F. below zero for slow-moving trains the duration-strain factor of the 0.10% bessemer metal of about 0.5% may be exceeded for speeds of 50 to 60 miles per hour. The openhearth rails made under this road's ductility tests have a greater duration-strain factor than the bessemer metal, and the practical experience in track for the severe winter of 1911 was only one rail of openhearth steel broken to 100 of bessemer steel. In 1912, the change was made from 0.10% bessemer steel to basic openhearth metal for all rails for the New York Central Lines.

Failure of Horse Creek Earth Dam

By M. C. Hinderlider*

SYNOPSIS—Seepage of water through 4 ft. of sandy loam and through shale beneath the loam appears to have led to the destruction of the reinforced-concrete outlet conduit, the washing out of 200 ft. of the dam and the destruction of 3600 lin.ft. of slope paving in an earth dam having a maximum height of 55.5 ft. and a total length of about a mile. About 10,400 acre-feet of water stored for irrigation were lost. Proposed methods of repair are described.

The Horse Creek Dam, one of the largest of the earth dams of the West, failed on the night of Jan. 28, 1914. About 200 ft. of the embankment, together with the outlet works, were destroyed, as also some 3600 ft. of concrete slope paving (see Figs. 1 to 6).



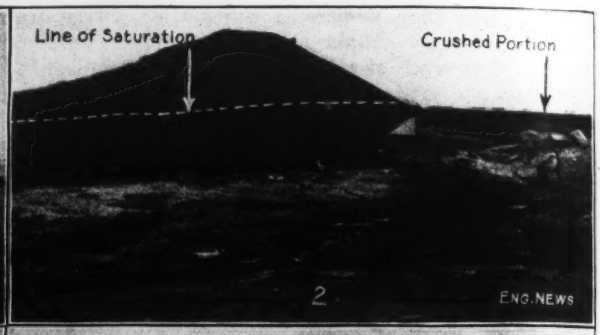


Fig. 1. General View of Break from Inside of Reservoir, Showing Destroyed Slope Paving

Fig. 2. East Abutment of Break, Showing Line of Saturation and Crushed Section of Outlet Conduit

Fig. 3. Base of Reinforced-Concrete Gate Tower and Joint in Same

Fig. 4. Looking East toward Break, Showing How Paving Slid Down

Views of Break in Horse Creek Earth Dam, Colorado.

General Description

The dam is located on Horse Creek, about 30 miles northeast of Denver, Colo., and was built to store water for the Henrylyn Irrigation District. The main structure consists of an earth dike 4550 ft. in length, extending in a straight line in an east-and-west direction across Horse Creek Valley, with an extension 600 ft. in length extending from the easterly end at an angle with the main structure, for the purpose of providing necessary freeboard at that end of the dam. The total capacity of this reservoir was about 17,000 acre-feet, but the available capacity was about 14,500 acre-feet.

The downstream slope of the dam, for a vertical distance of 16 ft. from the crest, is 1½ horizontal to 1 vertical, the remainder of the slope being 2½ to 1. The upstream face has a uniform slope of 1½ horizontal to 1 vertical and was paved with concrete. The crest width is 16 ft. The maximum height of the dam, which is at a point near the middle of the structure, is 55.5 ft. The contents of the dam amounted to 711,000 cu.yd. Of this, 34,000 cu.yd. had been placed on the crest after the first year's settlement, which amounted to a maximum of 7 ft. The average height is approximately 40 ft. The available freeboard at full reservoir was but 7 ft.

Plans for this structure were prepared by and work of construction carried on under the supervision of the Denver Reservoir & Irrigation Co. and the Henrylyn Irrigation District. The present State Engineer, John E. Field, is authority for the statement that certain plans were approved by his predecessor but that, apparently, the plans had been modified and construction work had been carried on without any supervision from the State Engineer's office. The construction of the dam was included with other work in a contract covering the construction of the whole at a flat price.

Foundation and Character of Material—The formation immediately beneath the dam consists of a sandy

*Of the Field, Fellows & Hinderlider Engineering Co., 811 17th St., Denver, Colo.

loam ... ing considerable clay. In connection with the prep... on of plans for repairing this dam, numerous borin... ave been made along the lower toe. These borings ... this surface material, with slight variations or inter... sions of strata of a more sandy nature, to extend to at least 15 to 18 ft. below the surface for three-fourth... of the entire length of the dam. Near the easterly ... of the dam, where the break occurred, the shale

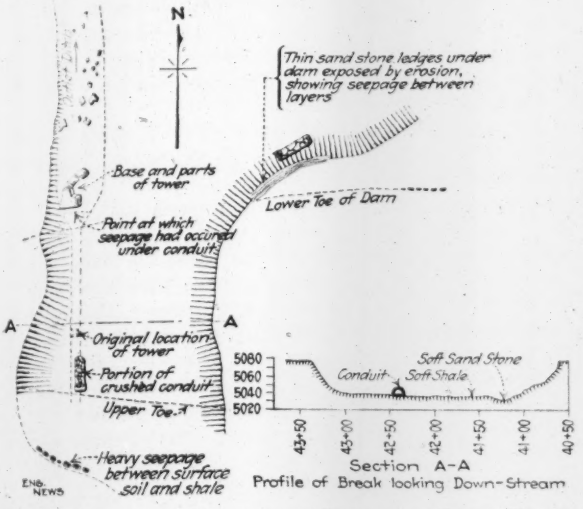


FIG. 5. PLAN AND PROFILE OF BREAK IN HORSE CREEK EARTH DAM

approaches the surface, gradually rising to a point from but 3 to 5 ft. below the original ground surface at the break.

The erosion in the break through the dam shows that the soil on which the dam rested at that point is from 3 to 5 ft. in depth. Below this soil occurs a soft shale into which holes were sunk from 14 to 20 ft. Adjoining this shale formation and passing diagonally through the dam, occurs a dike of soft sandstone, easily eroded. Both formations show a water-bearing stratum a few feet below the surface. At the lower toe of the dam, at the west side of the break, the laminated sandstone shows a considerable amount of seepage.

The dam, for the most part, is built of a sandy loam and clayey material taken from shallow borrow pits above and below the dam. In the upper courses of the dam a considerable part of the material is of a blocky shale nature and quite porous. In the preparation of the site for the base of the dam the surface of the ground over the entire site was plowed, after which all sod covering the upper one-third of the site was removed and deposited in the lower toe of the dam. Preceding the depositing of material in the upper one-third of the base of the dam, the ground from which the sod had been removed was corrugated with plow furrows about three feet apart. No further preparation of the lower two-thirds of the site appears to have been made.

CHARACTER OF CONSTRUCTION—The specifications provided that the lifts in the fill should not exceed 3 ft., but an examination of the banks at the point of failure and the testimony of eye witnesses indicate that some of the layers may have been as much as 4 ft. or even more than that. The writer is informed by the engineer in charge of the work that the first two feet of material taken from the borrow pits, and used in the lower course of the dam, was damp and packed well, but that all of the rest of the material was placed dry.

The earth was placed in the dam by means of dump wagons and spread with fresno scrapers. No sprinkling was done and no further packing of the material was required other than that furnished by the wagons and teams. No puddle trench, core wall or intercepting wall of any nature was used beneath the dam.

OUTLET STRUCTURES—At the lowest point in the Valley, or where the maximum height of dam occurs, there is a 12-in. cast-iron, lead-calked outlet pipe laid in concrete. This pipe is to be used only for draining the reservoir. The main outlet from the reservoir consisted of a reinforced-concrete arched conduit, with a span of 8 ft., forming the inlet and outlet to the gate chamber. The latter was of the same material and was located just in front of the crest of the dam. The arch and haunches of this conduit were, respectively, 9 and 18 in. thick. The walls of the gate chamber and tower were of ample thickness and the reinforcing steel seems to have been reasonably well placed but inspection of the ruptured structure showed an insufficient lapping of the reinforcing steel in the conduit near the gate tower. Smooth steel was used. The design was also faulty to some extent.

The outflow from the reservoir was controlled by two 3-ft. 9-in. by 6-ft. 3-in. cast-iron vertical gates of the ordinary type, designed to be operated under a maximum head of 22 ft. by double-geared hoists at the top of the tower. This arrangement permitted the water to stand in the tower at the same elevation as in the reservoir when the gates were closed. The outlet conduit was pro-

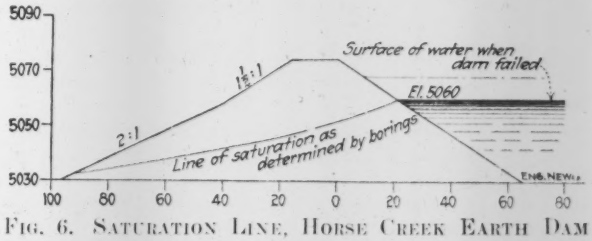


FIG. 6. SATURATION LINE, HORSE CREEK EARTH DAM

vided with two concrete cutoff walls or collars above and one below the gate tower. This gate tower, and also the conduit for its entire length of about 170 ft., rested upon the sandy clay loam formation heretofore described. The break occurred at or near this outlet (see plan, Fig. 5, and views, Figs. 2 and 3). The indications are that the break first occurred east of the conduit and gradually worked westward, cutting deeper into the formation under the dam west of the conduit. The escaping water eroded the soil foundation to a depth of from 3 to 8 ft. below the original invert grade of the outlet works where a stratum of shale and sand rock prevented further action by the water.

PAVING ON FACE OF DAM—In addition to the destruction of the outlet works and a section of dam about 200 ft. in length, the sudden emptying of the reservoir caused the destruction of about 3600 lin.ft. of the concrete paving on the face of the dam west of the break. This paving, which was composed of concrete 5 in. thick reinforced with No. 11 square-mesh fence wire, slid down the face of the dam from 10 to 20 ft. vertically, a considerable amount of the embankment breaking off at the crest in places and sliding into the reservoir. Figs. 1

and 4 show this condition. The paving was inadequately supported along the lower toe by means of a concrete wall 1 ft. wide and 2 to 2½ ft. deep. No concrete stringers were used beneath the paving. The destruction of the paving was doubtless brought about by the hydrostatic action of the water and saturated embankment immediately under the paving, coupled with the steepness of the slope and very slick nature of the material in the embankment. While the ice in the reservoir, which was from 15 to 18 in. thick at the time of failure, may have had some action tending to cause a failure of the paving, it was not the principal cause.

The thorough saturation of the earth face of the dam changed the angle of repose, thereby causing an unstable foundation for the concrete facing which, together with the hydrostatic pressure back of the paving, caused the rupture.

All the concrete was composed of native sand and hydraulic cement, no coarser material being used. The reinforcing seems to have been fairly well placed in the paving, but the concrete is soft and without life. The concrete in the outlet works, while of a better grade, is, nevertheless, of inadequate strength, the mixture having been 6.6 sacks cement to 1 cu.yd. of fine sand.

History of the Dam and Theories of Its Failure

The work on this dam was commenced in March, 1911. The water was turned into the reservoir in February, 1912, and allowed to rise to a height of 41 ft. above the lower outlet, or 14 ft. below the crest, thereby providing a total storage of 11,560 acre-feet or 504,453,600 cu.ft. After this water had been stored, seepage appeared along the lower toe of the dam for the greater part of its length. The aggregate amount of this seepage was not 1 cu.ft. per sec.—a comparatively trifling quantity for a structure of this length. This seepage, the writer is informed, did not increase the following year (1913) when the reservoir was filled to within 12 ft. of the crest.

At the time of failure the water stood 13 ft. from the crest. For some time a slight seepage at the lower end of the main conduit had been observed, but this had continued for a number of months without increase or signs of erosion. The writer was informed by a member of the Board of Directors that the latter had made a careful examination of the concrete conduit below the gate chamber about ten days before the failure and found no evidences of cracks or damaged concrete. This statement is in line with one by the resident engineer, who made an examination of the conduit above the gate chamber and of the latter structure previous to the last filling of the reservoir, and found no evidence of weakness or failure. At 4 p.m. of the day on which the failure occurred the attendant reports that he made a careful examination along the lower toe of the dam and outlet conduit, but could discover no increase in seepage.

The several theories advanced as to the cause of the break are as follows:

(1) The water may have passed through one or more of the pervious strata in the shale at or near the outlet conduit, causing a settlement and failure of that structure.

(2) Water may have found its way through a pervious section of the fill.

(3) Imperfect joints in the concrete gate tower may have permitted water to escape into the embankment around the tower, thereby causing the tower [illegible]tle and crack.

(4) Water may have found its way along [illegible] outside of the conduit, but this is hardly likely wit[illegible] collars provided and the character of puddle surr[illegible]ng the same.

The conduit may have collapsed, due to the [illegible]th pressure. One fact that gives some weight to th[illegible]eory is that a section of the conduit located abov[illegible]he gate tower lies in practically its original position, bu[illegible]as been crushed as if by excessive external pressure. Another theory which has some basis for consideration [illegible]hat the outlet works were dynamited.

In the opinion of the writer, who has mad[illegible] personal examination of the conditions at the break, the failure was due to water finding its way under the dam between the four feet of sandy loam upon which the dam rested, and the shale formation, as evidenced by the excessive amount of seepage now coming from the same contact just above the break. This seepage probably caused a settlement of the outlet conduit and tower, which, as has been mentioned, rested upon a sandy loam formation. This would cause the destruction of the conduit.

The view, Fig. 2, shows the line of saturation through the dam, at the point of rupture, while the section, Fig. 6, shows the points of saturation some distance west of the break, as determined by borings.

Plans for Repairing and Strengthening the Dam

Plans for rebuilding the dam, now being prepared by the writer, contemplate the use of a concrete core wall across the break, carried down into the shale and sandstone formation; the use of puddle trench and sheet piling beneath the remainder of the dam, where the formation seems to render the same necessary; the rebuilding of twin 6-ft. reinforced-concrete outlet conduits; and building a valve tower founded on shale or sandstone, using 60-in. packed valves, with special hoisting device.

The crest of the present embankment will be pulled down and used to build a new water face on a slope of 2½ to 1, which will be sufficiently flat to render it safe, after which the slope will be protected with a reinforced-concrete paving and vertical coping.

The freeboard will be increased to 14 ft. and the crest width to 18 ft. These repairs will be undertaken as soon as the plans can be completed.

Aside from the damage to the reservoir and the loss of about 10,400 acre-feet of valuable water, the damage caused by the break was nominal.

An Electric Locomotive with combination gear and rod drive has been completed by the Allgemeine Elektricitäts Gesellschaft for the Rhaetian Ry. (St. Moritz-Schuls line), Switzerland. The locomotive has capacity to draw a 200-ton train, or of starting a 180-ton train on a 2½% grade, attaining a speed of 17.5 miles per hour in 52 seconds. The maximum speed is 28 miles per hour. For easily running on curves it has two fixed and two movable coupled axles and two bogie trucks. The cab consists of a closed motor room and two drivers' compartments. There are two 350-hp. motors with gears on each end of their shafts, working against a common intermediate shaft. The gears have teeth set at an angle, the motor pinions being opposed on each shaft. The geared shaft drives a jack shaft between the third and fourth axles by means of inclined coupling rods. The jackshaft in turn drives the coupled axles. Single-phase (16⅔-cycle) current is taken from overhead conductors at 11,000 volts. It passes through a transformer so that the motor is fed at 300 volts. The motors are started with the rotor short-circuited.

The Manager Plan of Municipal Government

By Kenyon Riddle*

The advantages of the manager plan of municipal government are being discussed in so many cities just now that the following notes on the subject from one who has had the benefit of some experience as engineer-manager of a small city may be of interest.

Since most of the affairs of the smaller cities, at least, are of an engineering nature, the city manager should be generally posted in engineering. Since he may act as an agent or arbitrator between the governing body and the people, he should be tactful. As a judge or adviser of a great deal of the city's business—such as purchasing material, allowing estimates, recommending improvements and expenditures, submitting ordinances and suggestions in general for the approval of the administrators—he should be familiar with cost data, a good judge of benefits derived from different acts, an economist, honest, impartial and free from politics, and in general be purely a business man and *expert* servant of the commission.

As to working principles, these can best be illustrated as follows. Imagine three [or five] horizontal lines converging to one central point, these lines representing the governing body; and diverging from this point the number of lines necessary to represent the different departments. The focusing of all the lines into one point shows clearly centralization of responsibility.

In order for any act to be executed, it must first be passed upon by the legislative body as a whole, then condensed and made to pass through one point—the controlled executive—to the proper department heads. Now suppose the act was not carried out in a manner suitable to the people. They protest to the commissioners, whereupon, in order to save criticism, they go directly to this single head, and in order to hold his job he gets busy. And finally, when the blame is located, it may be found in some subordinate official of some department; however, the act is easily traced and finally filtered through the group.

The principal objection to this new plan is the fear of one-man power. The new plan eliminates one-man power. With the commissioners acting as a *group*, through one *controlled* executive, all of the fancies, hobbies or any peculiar ambition that one man might have are neutralized by the combined judgment of the other members of the commission. Also, if any one of the board is interested pecuniarily, the passing of every act by the group destroys all opportunities for such deals.

The manager is servant and executor, not boss.

Under the council form of government, there was confusion most of the time, due to jealousy among the councilmen, politics, special interests, lack of expert advice. Further confusion arose because the affairs of the city were divided and subdivided among the several committees and members and also because of complexity in general.

These same things may exist in a commission, but there is much less chance. Jealousy may exist, due to the fact that special charge of the different departments, etc., is divided among the commissioners. There is less danger from politics because the body is smaller in number and each man is more conspicuous. Special interests may be more detrimental under commission form because of each member having special charge over his departments. Lack of expert advice may be less dangerous because at no time does all of the board go out at once and the older members are apt finally to become posted on certain expert knowledge—at the city's expense. And finally, one of the greatest features in favor of commission form over the aldermanic or council form is the fact that an entire new body does not come in and spend the first few months of their administration tearing down what their predecessors have started. Also, since the majority of the cities do not lay much stress on records, it is possible for the remaining commissioners to put the new man wise to their past proceedings.

I maintain that it is possible for all of these objections to be eliminated, partially or wholly, by the engineer-manager plan. As a first step toward this end, a change should be introduced in the present laws of the various states, authorizing the commission plan, so that every act of importance shall be acted upon by the commission as a *whole*. For, with the two main ideas involved in the commission form—that is, the Lynn form (as in Lynn., Mass., and as has been adopted in Kansas) and the general plan (as in Galveston and Des Moines)—there is one great weakness, viz: In the former, electing its members to specific posts and, in the latter, appointing its members to perform special duties after they are elected. Both methods are accompanied by such objections as individual control, or as many different governments as there are commissioners, and in general lack of unity. Furthermore, no matter whether the commissioner is elected to his duties or whether these are assigned, it is hardly possible to get a true representative of the people (as the commissioner should be) when technical fitness has to be considered. Therefore, in order to avoid every objection which can be imagined from a lack of unity and individual action, elect the commissioners *at large*,* make them responsible as a *body*, and make it necessary for every important act to be passed upon by the entire body, thereby balancing or equalizing the freak ideas that any of the members may possess.

The next and, as already suggested, an equally important step, is to provide a manager (and for most places an engineer-manager) to serve the commission as an expert. In no case would it be policy for the state to define his duties. It is quite likely that the different towns or cities wishing to adopt the manager plan would have distinctly different views as to the duties of a manager. Some might make the qualifications strict as to his ability to regulate social matters, others might wish a manager of distinctive financial ability—but still the principal requirement should be experience and fitness in matters of an engineering nature.

It is quite evident that the duties of the city manager should be fixed by city ordinance. As a model for such an ordinance, suitable for the majority of places, the following is suggested:

AN ORDINANCE

Creating the Office of City Manager, Defining his Duties and Salary. BE IT ORDAINED By the Mayor and Commissioners of the City of :

City Manager: There shall be appointed by the Mayor and Commissioners a City Manager who shall be the administra-

*Engineer-Manager, City of Abilene, Kan.

*This is the general practice under the commission plan.—Ed.

tive head of the municipal government subject to the supervision and control of the Commissioners and he shall be responsible for the efficient administration of all departments. He shall be appointed without regard to his political beliefs and may or may not be a resident of the City of when appointed. During the absence or disability of the City Manager the City Commission may designate some properly qualified person to execute the functions of the office.

Powers and Duties of the City Manager: The powers and duties of the City Manager shall be

(a) To see that the laws and ordinances are enforced;

(b) To attend all meetings of the Commission, with the right to take part in the discussion but having no vote;

(c) To recommend to the Commission for adoption such measures as he may deem necessary or expedient;

(d) To give all lines and grades for city improvements which require the same;

(e) To have control, management and direction of all improvement work of any nature which pertains to and comes under engineering principles. The above duties shall include the making of estimates, supervision during construction, inspection and the maintenance thereafter; he shall have control and management of all streets and alleys. He shall have charge of and control the entire water and sewer system and keep a complete underground record of the same.

(f) To be inspector of all wiring, sewer connections, plumbing, water connections and chimney construction. He shall approve all estimates of the cost of public works, and recommend to the City Commissioners the acceptance or rejection of the work done or improvements made.

(g) To recommend to the Commission the appointment or removal of all heads of departments and all subordinate officers and employees of the City which come under and pertain to principles of engineering; all appointments to be upon merit and fitness alone.

(h) To exercise control over all departments and divisions created by the Commission.

(j) To keep the Commission fully advised as to the financial condition and needs of the City.

All the powers enumerated, however, shall be subject to the supervision and control of the City Commission.

Salary: The City Manager shall receive such salary as may be fixed by ordinance of the Commission.

All ordinances heretofore made so far as inconsistent and in conflict with this ordinance are hereby repealed.

The Timber Groins for Beach Protection at Asbury Park, N. J.

By Charles H. Higgins*

The terrific damage done to many beach resorts on the coast of New Jersey, Delaware and Long Island, by the two ocean storms at the end of December and the beginning of January,† direct attention to the beach protection of Asbury Park, which suffered comparatively little damage on those occasions. The method in vogue there is to allow a free sweep for the surf but to reduce the energy in the waves by means of carefully designed and well built system of timber groins (sometimes termed jetties).

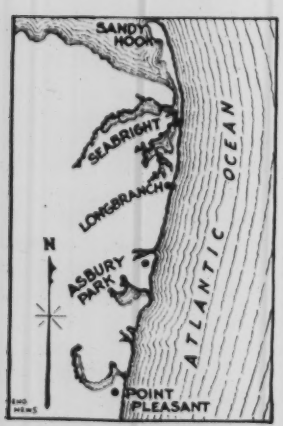


Fig. 1. Point Pleasant to Sandy Hook

An examination of a map of the New Jersey Coast shows a sandy beach extending from Barnegat to Sandy Hook, with Asbury Park occupying a central [illegible] strip of the coast is shown in Fig. 1. The [illegible] consists of a sand beach, beyond which there [illegible] sand bar, just covered at low water. Betwee[illegible] and the bar, there is normally a strip of deep [illegible] which the prevailing current is parallel with [illegible] and usually in a northerly direction. Dur[illegible] from the northeast or southeast, this current [illegible] becomes so rapid that a strong swimmer ca[illegible]

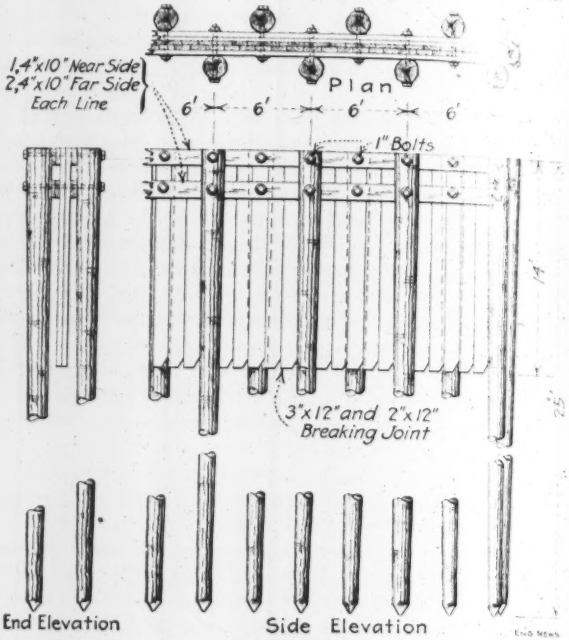


Fig. 2. Design of Groins Built at Asbury Park

progress against it. It is this prevailing northerly current, between the beach and the bar, which tends always to move the sand toward Sandy Hook. The latter was probably built by this action.

It is the northeaster which erodes the beach. It strikes it, not at right angles, but on a diagonal line. The waves break in a progressive line along the beach and the water runs back with a whirling motion, which carries the sand into the current described above. This current is below the surface of the water and the waves pass over it as they strike the beach. It is, therefore, sometimes referred to as an undertow.

Theory of the Groin System

The theory of the groin system is to prevent this diagonal swirling action which carries the grains of sand down to the current, and also to force the current farther out shore, by obstructing its course. The groins then, are not designed to resist the waves as they hurl themselves upon the beach, but to resist the secondary movements of the water, which follow the breaking of the waves, by making the returning water run back on a line at right angles to the general direction of the beach. This results in a lower velocity and a consequent reduction of carrying power. The groin also resists directly, the movement of the undertow, parallel to and along the beach, thus forcing it farther out and broadening the beach. This still further breaks the force of the waves.

The groin system, then, is more than a defense. By progressive extension, it can be made to build the beach

*Consulting Engineer, 15 Exchange Pl., Jersey City, N. J.

†The effects of the storms of Dec. 25-26 and Jan. 3-4 were discussed in "Eng. News," Jan. 8, 1913, p. 102; Jan. 15, p. 135, and Jan. 22, p. 168. On the same page of the Jan. 15 issue is an article entitled "The Prevention of Storm Damage to Shore Lines."

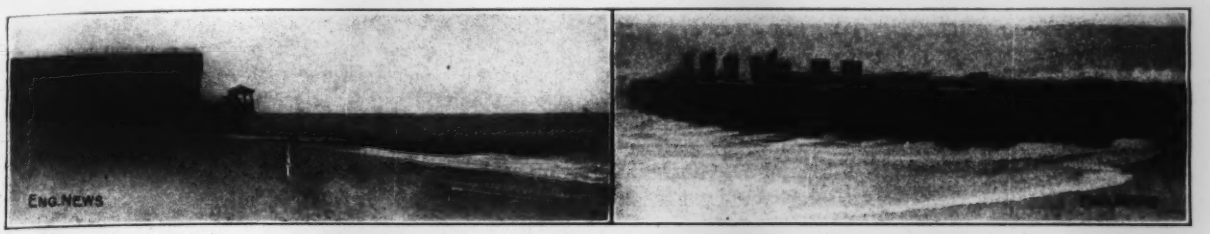
out from an existing shore line. Sand is deposited between the groins when westerly winds prevail.

In the autumn of 1907, the Public Grounds Commission, of Asbury Park, asked for bids, the contractors to submit plans and specifications with their proposals. The writer prepared the plans and specifications submitted by the successful bidder, which provided for a system of timber groins, and later he supervised the construction.

The design was based on the practice and accumulated experience from observations of the successes and failures resulting from groin building along that coast.

A feature believed to be novel was the distinct recognition in the design of the relation between the length of the groins and the distance between them. This ratio is based on the diagonal movement of the waves and can be understood from an examination of the diagram. Roughly, the distance between groins should not, under conditions obtaining here, be much greater than their effective length. Another "first principle" recognized was that the groins should slope outward, at an angle about equal to that of the beach to be maintained, with their outer ends well down, at least to the average sea level.

The second requirement essential for the most successful groin system is based on the theory of offering the least possible resistance to the sea, and that the groin accumulate sand during times of westerly wind. The most successful groin is that which is completely buried by the sand. The sand accumulated acts as protection during the fierce northeasters; while the action of the groin is to resist the displacement of this protecting sand.



FIGS. 3 AND 4. VIEWS OF BEACH AND GROINS AFTER THE RECENT VIOLENT COAST STORMS

METHOD OF CONSTRUCTION

The yellow-pine timber and piles used in this construction were first treated with creosote—12 lb. absorption to the cubic foot. The bolts were heavily galvanized.

The piles (14 in. or more in diameter at the butt and about 25 ft. long) were jetted to a penetration of about 20 ft. by means of hydraulic jets of 1¼-in. pipe 20 ft. long, fastened to hose at the upper end. The sand beach of Asbury Park bears on a stratum of blue clay about 20 ft. below the surface, and the piles were jetted to this stratum. The jets were manipulated by two men; and two jets were sufficient to rapidly penetrate to the clay stratum. Then with one jet in operation, a pile was hoisted by means of a block and fall attached to shear legs, and set in the hole, the sand quickly filling in around it.

The wales or stringers are spiked in place on the first row of piles and the sheathing jetted down in the same manner as the piles; although in this case, a single jet will soon push the sheathing in place. Upon the sheathing, wales are spiked and the second row of piles jetted in place; after which all are bolted together. Fig. 2 shows the complete design of the timber groin, while Figs. 3 and 4 are views of groins in actual service.

Low jetties, i.e., service jetties with their tops at about mean tide level—are very difficult to construct, as the men can work only during low water. It is practically impossible to carry on the work in the summer, as very low tides are so infrequent then; while in the winter, storms often delay the work for several days. The work can be done in the winter, but the spring and fall are better times. At these seasons, when off-shore winds hold down the tide and smooth the sea, the work can be pushed most of the day. But always, it is a case of watching the wind and tide and grasping the opportunities afforded by low water. The work at Asbury Park was carried on during the winter, spring and autumn months.

That the groin system has proved effective here, is evidenced by the fact that certain structures which were dangerously exposed in 1908 were not affected by the heavy storms of Dec. 25-26 and Jan. 3-4. The system is in excellent condition after its service of six years; neither teredo nor decay have developed. Shortness of funds prevented the construction of as complete a system as perfection of design might demand; but it has demonstrated its value and is amply worth the $30,000 it cost. On Jan. 24, the Public Grounds Commission expressed its satisfaction over the performance of the groin system.

CONCLUSIONS

The conclusions to be drawn from the behavior of the jetty system of Asbury Park, under trying service conditions, are several. First: It has shown that a sand beach can be not only protected but actually extended; and at a most reasonable cost. Second: The entire New Jersey coast could be adequately protected at far less cost than that represented by the damage resulting from a single great storm, like the one early in January, 1914. Third: For such protection, continuity in the groin system is essential. Asbury Park, with a mile of shore front, under single control, is in an exceptionally advantageous position.

County Highway Project in California—Although California is a large state and its counties are correspondingly large, in point of area, a proposition for a county having about 35,000 population to issue long-term bonds to the amount of $1,125,000 to improve roads seems a little extraordinary even to people in the East, where they are accustomed to see $50,000,000 state bond issues so freely authorized and spent. Riverside County, California, has recently authorized by a special election a bond issue of $1,125,000 for building a 273-mile road system; and, according to the Riverside "Enterprise," is now congratulating itself that a New York bonding house appears willing to take up the bonds. This sum means a levy of $32.20 on every man, woman and child in the county; or a tax of probably $1.60 per year per capita for interest alone, to say nothing of the maintenance expenses of the improved roads, and the sinking fund charges.

Reconstruction and Relief of the Rocky Branch Sewer; St. Louis, Mo.

By W. W. Horner*

SYNOPSIS—All large cities have problems of enlargement and improvement of sewer systems, due to old sewers of insufficient capacity or built on more or less haphazard design. The accompanying article describes the improvement of a large main sewer, in a built-up section of a large city, including four special features: (1) improving the grade by cutting out the invert and rebuilding the bottom; (2) a relief sewer to provide the necessary capacity; (3) a siphon to keep the sewer below the surface in a hollow; and (4) a tumbling chamber or vertical drop in the sewer.

About 1860, the western expansion of the city of St. Louis carried the settled district beyond the immediate

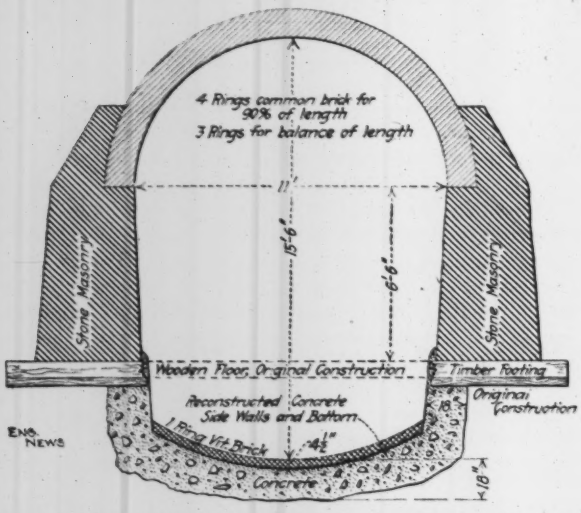


Fig. 1. Typical Enlarged Section of Rocky Branch District Sewer; St. Louis, Mo.

slope of the Mississippi River and made necessary the construction of sewers for the upland valleys behind the bluffs. The western district lay entirely in the valleys of two streams: Mill Creek entering the Mississippi to the south of the central portion of the city, and Rocky Branch two miles north. The construction of main track sewers for these valleys was carried on simultaneously. Contracts were let for short sections according to the demand and to the funds available. Up to 1876 the funds were principally from special bond issues and later by appropriation from municipal revenue.

The Mill Creek sewer drains an area of about 5000 acres. The sewer is of horseshoe section, with dimensions in its lower portion of 15x20 ft. Until recently, it was the largest sewer in the city, and for a long time was considered the largest in the United States, when both size and length are counted. The new Harlem Creek sewer, begun in 1905 and now complete, is considerably larger, the lower end (of reinforced concrete) measuring about 19x20 ft.

*Principal Assistant Engineer, Sewer Department, St. Louis, Mo.

Construction of Original Sewer

The Rocky Branch sewer, originally the second of importance, was begun about 1860. We can find no record of the original plans of the engineers, and consequently have no idea as to the area which the sewer was expected to drain or whether any specific runoff values were used. The lower portion of this sewer was constructed in the bed of the Rocky Branch; it seems possible that the size was determined largely with relation to the bank full area of the stream. It was of horseshoe section, Fig. 1, about 12 ft. wide and 11 ft. high for 4000 ft. from the river to 19th St. Thence to Elliot Ave., 4500 ft., it is of similar shape, 11x10 ft.

For a large proportion of the length the side walls of the sewer rest directly on rock, and the bottom was the rock surface in its natural condition. When solid rock was not found, a foundation was constructed by laying under each wall a row of heavy cottonwood timbers about 12x12 in. On these, similar cross-timbers were laid close together to form a heavy floor. The wall masonry was built directly on the upper timbers. The sidewalls for nearly the whole length are limestone masonry and rather rough, while the greater portion of the arch is of brick.

The sewer was not built from the river westwardly but the creek was inclosed in detached sections wherever the demand was greatest. About four blocks of sewer (between Hall and 9th Sts.) was completed in 1863, and a portion near 19th St. in 1865, while the outlet was not finished until 1872.

Western Extension—The sewer was completed to Elliot Ave. in 1876, at which time the Elliot Ave. sewer (7x9-ft. oval), previously constructed, was connected. This seems to have marked the completion of the system as contemplated up to that time. The contours on a topographical map of the city show that the original watershed line of the Rocky Branch was about as indicated by the dot-and-dash line on Fig. 2. They show also that much of this territory, especially in the northern portion, consisted of small pockets draining in part to ponds and sink holes and probably contributing very little to the runoff of the valley. The area west of this line (west of Prairie Ave.) was of similar character to that just described. The strip between Prairie Ave. and Sarah St. was flat and swampy, and contained many ponds, some of large size.

This area received a large runoff from the west, and had a slight slope to the south where the drainage finally found an outlet in Mill Creek. In 1876, however, when the Rocky Branch sewer was complete to Elliot Ave., the upper end of the Mill Creek sewer was still considerably further east and far south of this territory. The district near North Market and Warne Sts. had built up with slaughter houses, and the whole of the flat districts had become exceptionally unsanitary. In 1876 also, the city limits were extended from about Grand Ave. to a

new line about two miles west, and all the area shown on Fig. 2 was taken into the city. In 1878, the construction of the main Rocky Branch westwardly was authorized in order to drain about 1000 acres west of Grand Ave.

We do not know what estimates of the runoff conditions in the valley were made at that time, or what general values of rainfall and runoff factors had been in use. In the reports of 1878 it is noted "all *new* sewers will be designed to carry off 1 in. of rainfall per hour from the whole area drained and are not to run over three-fourths full." With the addition of the 1000 acres to the drainage area, the sewer east of Elliot Ave. would be overcharged, even under this rule. This was probably recognized at the time but the extension authorized was the only feasible plan. This extension was carried on continuously until 1895, when the main trunk was completed. In the meantime many large laterals and district sewers had been completed, and street paving and building had followed closely on the sewer work.

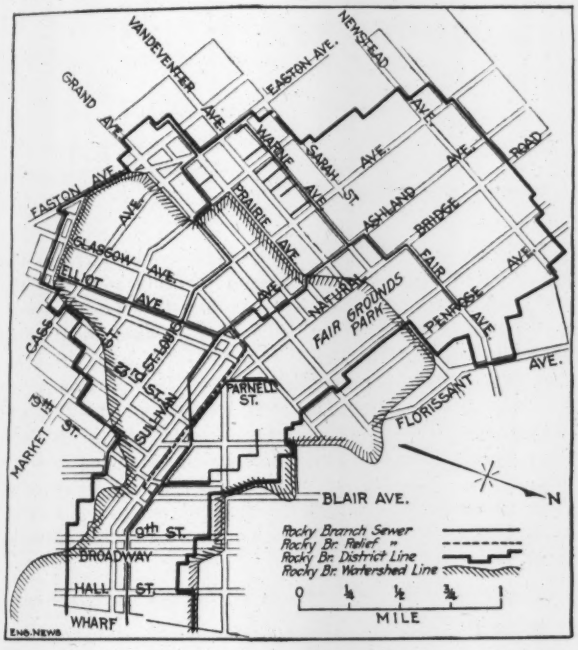


FIG. 2. MAP OF DISTRICT SERVED BY ROCKY BRANCH SEWER, ST. LOUIS, MO.

ENLARGEMENT OF THE LOWER PORTION OF THE SEWER

About this time the serious overcharge of the main sewer became evident from reports of flooded cellars near Broadway, 11th St., and in the pockets at 21st St. and Jefferson Ave. A recomputation of the whole system was made, using the McMath formula for St. Louis, in which the runoff, $Q = 2.75 \times 0.75 \sqrt[5]{15 A^4}$ the numbers representing the rainfall per hour, the percentage of runoff, and the lateral slope of the surface per 1000 ft., and A being the whole drainage area in acres above each point. The capacity of the old sewer was also compiled and showed quickly varying values from section to section owing to the badly "chopped" grades. These values showed an overcharge which varied from 50 to over 100%.

In 1905, it was decided to enlarge the old sewer between the outlet and Elliot Ave., by methods similar to those previously employed in the Mill Creek sewer. This enlargement consisted in increasing the area by excavating the invert, and constructing a new invert below the original flow line. The application of this method in the Rocky Branch sewer had many obvious advantages: it gave a considerable increase in area of waterway; it abolished the old rough and uneven bottom and provided a smooth invert; it permitted to some extent the equalization of water-line grade; and chiefly, it could be carried out with little interference with traffic or inconvenience to residents and business in a district which had become quite congested.

On the other hand, some misgivings were felt because, though minor repairs and local reconstruction of the arch has been made at various times between 1887 and 1900 at a cost of about $11,000, and the sewer as a whole was believed to be in a good condition, it was now from 30 to 45 years old and had been constructed before portand cement came into use for sewer work. Also, the work required in underpinning the walls of the section founded on timber and in blasting rock within the sewer was of a very delicate nature; and the necessity for fluming the dry weather flow and the chance of sudden flood in the sewer made the work very hazardous.

This work was started in July, 1906, near 11th St. (working west) and also at the outlet. At the lower point, however, the work was stopped several times by high water in the river, and another gang was started east from 11th St. The bottom was partly of wood and partly of the solid rock. The flumes were carried on heavy cross-timbers set into the side walls near the spring line, giving good head room for the men. No attempt was made to carry a large flow of water as it was considered dangerous to work in the sewer in wet or rainy weather.

In the portions having wooden bottom, the cross-timbers were cut off with axes as close as possible to the side walls, usually two or three inches. After some excavation had been done, the stub ends were cut off about a foot back under the wall, but in general this was impossible and the concrete had to be laid under and around the stubs, often reducing the width of the sewer by a foot at this point. The old timbers were found to be 12 in. thick and from 18 to 30 in. wide; they were square and laid close together. The timber was found in good condition, but after storage in the air for three or four months it rapidly crumbled away.

The soil under the timbers was a blue sandy clay or a coarse sand and gravel, except at the west end. It was hardly moist and quite firmly compacted by the weight of the sewer so that the excavation was not difficult if done immediately after removal of the timber. A concrete invert 12 to 14 in. thick, and the additional portion of the side walls (up to and over the timber stubs and joining the old masonry walls) were put in at one operation. A course of vitrified brick in cement mortar was laid on the invert. The old side walls were pointed up with cement mortar.

Where the work was in rock, air drills were used and holes as deep as 6 ft. were fired without damage to the sewer. The rock was excavated as near as possible to line and less than 12 in. of concrete was used. The most

TABLE I. PUBLIC SEWERS OF ROCKY BRANCH DISTRICT, ST. LOUIS, MO.

Location	Built	Cost	Size, ft.	Length, ft.	Grade, %	Velocity, ft. per sec.	pI or rate of runoff for time T	Acres drained	Runoff, cu. ft per sec.	Capacity, cu ft per sec. — actual	final
Fair Ave.:											
North of Lee Ave.	1895	$15,550.00	5½	130	0.33	8.4	2.12	78.3	166	[illegible]	
From Lee to Kossuth Ave.			6	510	0.33	8.9	2.00	155.6	327	[illegible]	
Kossuth to Margaretta Ave.			6½	570	0.33	9.3	2.08	203.2	422	[illegible]	
Margaretta to Sacramento Ave.			7½	640	0.33	10.2	2.03	291.9	593	[illegible]	
Sacramento to Natural Bridge Ave.			8	320	0.33	10.5	2.00	328.4	656	[illegible]	
In Natural Bridge Ave.	1888–1892	34,900.00	8	700	0.30	10.0	1.96	338.8	664	[illegible]	
In Clay Ave. to Ashland Ave.			8½	880	0.30	10.4	1.92	452.4	867	[illegible]	
In Ashland Ave. to Warne Ave.			9½	530	0.25	9.5	1.92	452.4	867	[illegible]	
In Ashland Ave. to Prairie Ave.			10½	1440	0.50	15.5	1.83	908.8	*570	[illegible]	
In Hebert St.—Grand Ave.	1878–1885	64,470.00	10½	1250	0.75	19.1	1.80	1011.7	*1732	[illegible]	
To Glasgow and Sullivan Aves.			10½	1600	0.50	15.5	1.73	1130.0	*1872	[illegible]	
To Elliot and Sullivan Aves.			10½	330	0.50	15.5	1.72	1139.1	*1878	[illegible]	
To 21st and Palm Sts.	1871–1875	120,560.00	10x11	3450	0.55+	average		1964.0	*3250	[illegible]	3400
To 19th and Branch Sts.			10x11	1043	0.60	average		2035.0		[illegible]	
To Buchanan and Branch Sts.	1865	6,840.00	10x11	190	0.70	14.5		2148.0			3630
To Blair Ave. and Branch Sts.	1864–1876	52,390.00	11x12	260	0.70		1.58	2148.0	°3283		
To Ninth and Branch Sts.			11x12	1377	0.90+			2284.0	°3463		3400
To Hall and Branch Sts.	1861–1863	*23,840.00	11x12	1350	0.65	21 to 28	1.56	2436.0	°3693	1980+	
To Levee and Branch Sts.	1871–1872	47,200.00	11x12	770	1.25			2478.0			
Outlet section			11½x13	230	1.25		1.51	2478.0	°3700		3400
			9½x15	80	1.25						
District sewers*				3505							
Public sewers:											
Upper end to Elliot and Sullivan Aves.		114,920.00		8900							
Elliot Ave. to Blair Ave. & Branch St.		135,720.00		4943							
Blair Ave. to Outlet		115,110.00		3807							
Totals		$365,750.00		21,155							

*About 100 acres in Fair Grounds Park taken with pI value of 0.90.

°About 134 acres in Fair Grounds Park taken with pI value of 0.80.

Capacity of portion reconstructed and enlarged to 12x14 ft., 3400 cu.ft. per sec.

Capacity of relief sewer, 1860 and 2090 cu.ft. per sec.

*District sewers; 12, 15 and 18-in. pipe; 2x3 ft. and 2½x3½ ft. brick.

difficult situation was that in which the old sewer was on timber while the new bottom was in rock.

At one point east of Broadway, when the underpinning was started, the brick in the crown of the arch began to crack from the pressure and the work from the inside was abandoned. The sewer was stripped from above for over 200 ft. and, when the arch was removed, a portion of it was found to have only three rings; the remainder was four-ring work, with some masonry haunching. The work in this section proceeded in the same manner as before, most of the side walls being underpinned and utilized, after which a new brick arch with concrete haunching was built.

West of 14th St., the soil was found to be a fine yellow sand overlying the rock. After several days of rain, during which the flumes had overflowed and the work been flooded, work was started and during the day a section of the timber bottom was removed. Another rain followed in the night and the sand washed from under the timber stubs, causing the collapse of about 40 ft. of the sewer and serious incidental damage. The débris was cleared out and the work handled from the surface, but on account of wet weather, it was for some time impossible to stop the flow of sand from under the bottom ahead, and before this was finally caught and sealed, nearly 200 ft. of sewer had been destroyed.

This was rebuilt on concrete invert, with concrete sidewalls and haunching and a brick arch, but the work ahead was of too dangerous a nature to permit a continuance of the methods employed and was stopped at Blair Ave. In all, 3800 ft. had been reconstructed west from the river, bringing the work to within 350 ft. of the end of the old 12x11-ft. section. This section had been deepened by an average of 3 ft., so that the sewer is now called a 12x14-ft. section. The area was increased from about 111 sq.ft. to about 139 sq.ft., and the section had smooth bottom and improved sides, replacing the old masonry side walls and irregular invert.

It was estimated that the change would warrant the use of 0.013 for "*n*" in the Kutter formula instead of the 0.017 which had been considered fair for the old sewer. On this basis the capacity had been increased about 75%. The total cost of this work was $111,325 or a little less than $30 per ft. The original cost of this portion which was reconstructed was $120,000, or $32 per ft. When it is considered that the original work was done in the '60's when values were very low, and was constructed through nearly open country, it is believed that an increase of 75% in capacity through the present congested district at less than the original cost is a remarkable achievement.

Enlargement of the Western Portion of the Sewer

Along the western portion of the sewer, at Elliot Ave., and even much farther west (near Vanderventer Ave.), the trouble had been aggravated year by year, and in 1912 it was decided that the relief of the western portion of the city could no longer be delayed. This territory had reached a stable urban condition. In that year the capacity and runoff were again computed, this time by the application of the rational method as developed by the Sewer Department's rainfall curve for St. Louis*. The results are shown in Table I.

The average grade from Blair Ave. to the river is about 0.9%, and this may be taken as the effective grade, as the crown of the arch rises above it only at one point and by a slight amount. This grade meets the Mississippi at an elevation of about —16, equivalent to a stage of 16 on the St. Louis gage. This elevation is exceeded in June and July about seven years in ten.

As shown by the table, this sewer will not be seriously overcharged for the critical rain (2.73 in. per hour for a 30-min. period) when the river is at or below 16, but will be increasingly inadequate for such rains at higher stages. A rate of 2 in. per hour for this period has oc-

*"Engineering News," Sept. 29, 1910.

curred nine times in 20 years, all but two being in June and July. This sewer will be adequate for a 2-in. rain when the river is at a stage of 35, which is nearly high water, and has occurred only three times in ten years. In this case, however, the hydraulic gradient will be so close to the street level that cellars will be flooded at and east of Broadway.

A ten-year hydrograph of the Mississippi shows that the river was at or above 35 on 23 days in 610, during June and July, and the probability of a rain exceeding a rate of 2 in. per hr. for 30 min. on any particular day of those months is about 1 in 183. Thus the probability of coincident occurrence of the two phenomena may be taken as $23/610 \times 1/183 = 1/5000$, or about once in 80 years, a much more remote chance than the direct one of a critical rain at low water. Other combinations of river stages between 16 and 35 with rain rates between 2 and 2.73 in. do not result quite so favorably, but on the whole it seems improbable that it will ever be economical to provide additional capacity below Blair Ave.

Present Relief Measures

Table I shows that the overcharge west of Elliot Ave. varied from nothing to 40%, while the old 10x11-ft. sewer from Elliot Ave. down to the upper end of the reconstruction at Blair Ave. was over 100% deficient, and it was decided to relieve this latter section before anything was attempted farther west. As a continuation of the methods of enlargement used on the lower portion was known to be impracticable, on account of the soil conditions and the possible damage to private property should another section collapse, the only alternative was adopted, that is, an independent relief sewer.

It is obvious from the table also that the diversion of the whole flow of the 10½-ft. sewer west of Elliot Ave., leaving in the 10x11-ft. sewer the flow from the Elliot Ave. sewer and the remaining laterals below, would be a very satisfactory solution of the problem. It was decided, therefore, to construct a relief sewer for this section with a capacity of 1800 cu.ft. per sec. at the upper end. It was thought best to avoid interference with the lower laterals as far as possible, but to increase the capacity of the relief where a lateral had to be intercepted.

With the ends of the relief sewer fixed at Sullivan and Glasgow Ave. and Blair and Branch Ave., and with the added condition that it must turn to the north on Glasgow to avoid interference with the Elliot Ave. sewer, various lines were surveyed and soundings were taken. All these lines involved the use of Palm St. to one of the intersecting east and west streets, thence to Blair Ave. and south to Branch. This involved the use of two sides of a triangle, the combined lengths of which were greatly in excess of the length of the old sewer, so finally it was determined that the new sewer must follow Palm St. along the line shown in Fig. 2. This is the shortest possible line but has the great disadvantage of crossing the old sewer at 23rd St., and of running parallel to the 4x5-ft. sewer on Palm St.

Plans were prepared for a 12-ft. circular sewer with nearly a straight grade (about 0.7%) from end to end.

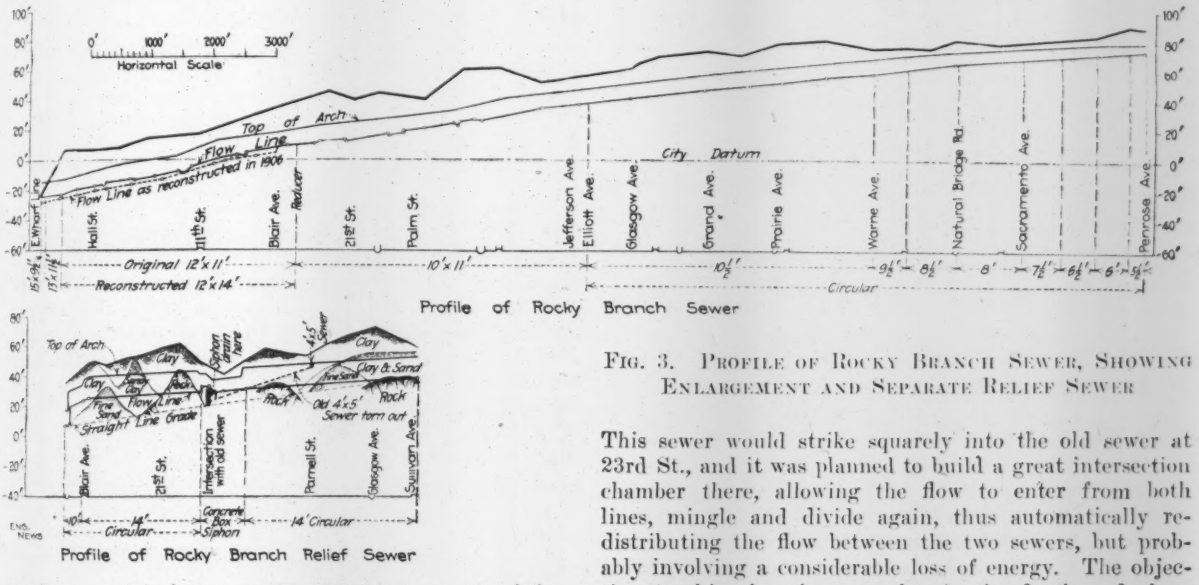


Fig. 3. Profile of Rocky Branch Sewer, Showing Enlargement and Separate Relief Sewer

This sewer would strike squarely into the old sewer at 23rd St., and it was planned to build a great intersection chamber there, allowing the flow to enter from both lines, mingle and divide again, thus automatically redistributing the flow between the two sewers, but probably involving a considerable loss of energy. The objection to this plan, however, lay in the depth and character of the excavation. The average cut for the lower half would have been over 40 ft., and for the upper half over 30 ft. The flow line for this scheme is shown as a dotted line and the character of the material is also shown on the profile of the relief sewer (Fig. 3).

In addition to the great expense of excavation in sand and heavy rock at these depths a great deal of damage was anticipated to abutting property, nearly all of which is built up with two-story brick residences and flats set close to the street line. After a close study of conditions, it was decided to raise the general elevation of the sewer to as near as possible the surface of the street. This was done and the profile of the relief sewer shown on Fig. 3 was adopted. This change introduced three special features: (1) the sewer had to be increased from 12 to 14-ft. diameter, with a consequent widening of the trench; (2) it became necessary to design a special structure to carry the flow over the old sewer at 23rd St. without involving any change in street grades; (3) special consideration had to be given to caring for the 15-ft. drop at the lower end. The two latter features will be described later in detail.

The change as a whole did not make a very large difference in the estimated cost for actual construction; for, though most of the rock work and a great portion of the wet sand were eliminated, the yardage was reduced only about 10%, owing to the wider trench and the excavation for the special work. With the flatter grades and the consequent enlargement of the sewer, the amount of masonry was largely increased, and the special work at Blair Ave. and 23rd St. was very expensive. The cost of construction was reduced somewhat, but the liability for damage to private property was reduced to a minimum, which was of the greatest importance as, even with all precaution, the contingencies for this item are still considerable.

Because of the congested nature of the territory and the small amount of working room the main sewer is built of brick, as it allowed of the most economical storage of material in the street in advance of the work,

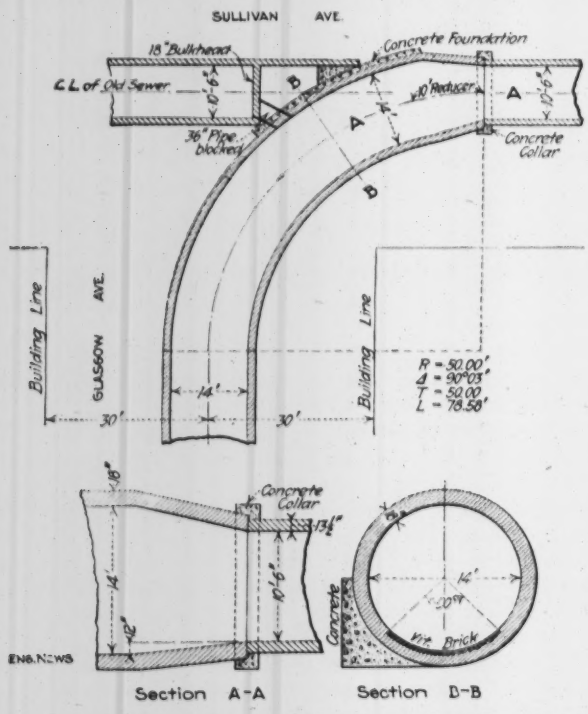


FIG. 4. INTERSECTION OF NEW AND OLD SEWERS

required little plant, and permitted easy handling and rapid progress. It was chosen in this instance in spite of the fact that all sewers over 9 ft. have in recent years been built of reinforced concrete. The main sewer is 14 ft. diameter, circular section, with four rings of brick (18 in.). It is of hard-and-red common brick, except that the inside ring for the lower quadrant is of vitrified brick. The brick is laid in portland-cement mortar (1:3), and the outside of the arch is finished with a ½-in. coat of the same mortar.

Beginning at Sullivan and Glasgow Ave., the present work provides for breaking out a section of the old 10½-ft. sewer to make room for the new sewer on a curve as shown in Fig. 4.

The crown of the new sewer is placed 2½ ft. above that of the other in order to decrease the depth of excavation. This rise was considered allowable: (1) because the old 10½-ft. sewer until relieved will be [illegible] pressure to that extent; (2) when a relief sewer [illegible] 10½-ft. sewer is built it will undoubtedly be high[illegible] than the latter; (3) after the relief sewer is built [illegible] 10½-ft. sewer flowing just full will have a much-hig[illegible] velocity than the 14-ft. and sufficient energy will be [illegible] ated at this point to raise the water level over a [illegible]. The dead end of the 10½-ft. sewer below the brea[illegible] bulkheaded and a 36-in. pipe connection is made into the new sewer. This will be blocked for the pres[illegible] but it is expected that it will be used to some exten[illegible] later to balance the flow in the old and new sewers.

At Parnell St., the old 4x5-ft. sewer is inter[illegible]pted by the relief, and the grade of the latter is increased slightly to provide the additional capacity. The 4x5-ft. sewer was removed at 23rd St. during the construction of the concrete siphon and was connected in at the upper end of the siphon. But as there is less than a foot clearance between this old sewer and the relief all the way from 23rd to Parnell St., the danger of weakening the former was so great that, though no definite damage is known, it was decided to rely upon it no further. It was cut off at Parnell St. and turned into the relief sewer and the long line from that part to 23rd St. now carries only the flow from one to two small pipe lines.

CONCRETE SIPHON

At 23rd St., the hydraulic gradient lies above the street level for several hundred feet, the maximum height being about 4 ft. The sewer here is changed to the wide shallow concrete box section shown in Fig. 5. The special construction consists first of 16 ft. of massive concrete sewer, with some reinforcement, in which the 14-ft. circle is changed to 14 ft. square; then comes 25 ft. of reinforced concrete changing the 14-ft. square to the 8x22-ft. section with the center wall. This latter section is constructed on a descending grade until the low point in the street surface is passed, at which point the sewer is just low enough to permit the replacement of brick paving.

About 150 ft. further, the grade changes sharply to a reverse slope and rises over the arch of the old sewer. Here one ring of brick was removed from the old arch, and concrete haunches were added, in order to secure the last possible inch of clearance between the old sewer and the street. From this point the grade is level for about 125 ft., when the surface is again high enough to allow a return to the circular sewer laid on the hydraulic gradient. The change is made through a 25-ft. and 16-ft. reducer, as at the upper end.

A portion of the old 4x5-ft. sewer is retained between its outlet into the 10x11-ft. sewer and the low point in the siphon, 75 ft. west. An opening 20x44 in. in the concrete bottom permits the ordinary dry-weather flow to pass through the small brick sewer into the old 10x11 ft. This also drains the siphon after a rain, and leaves the relief sewer dry below this point for several blocks. The amount of discharge from the relief into the old sewer at this point during a rain will approximate the flow of the 4x5-ft. sewer intercepted at Parnell St.

On account of the extreme width of this section, all gas and water pipes and also the service sewers had to be relaid under the sidewalks before construction was started. All small laterals for the low ground in the vicinity remain connected to the old 10x11-ft. sewer, and the con-

crete siphon is sealed completely for its entire length, except for the drain opening mentioned.

In the construction of this section, 6-in. wood sheet-piling was driven just outside the excavation line, in advance of the excavation. This was driven 6 ft. below the subgrade and was braced at the ground surface, leaving the space for construction of the concrete work unobstructed. This sheeting served as the outside forms for the concrete; it was afterwards cut off below the base of the street pavement and left in place in order that no settlement of the adjacent ground could occur. The construction was carried on from east to west or in the upstream direction. As the 4x5-ft. sewer became exposed in the bottom of the trench it was torn down to the subgrade of the siphon, planked over and the concrete bottom slab of th siphon laid on it. At the drain point in the siphon, nearly 66% of the height of the 4x5 ft. remained available.

This height decreased rapidly but the same method was pursued to a point where only a foot of the height remained. From that point on the brick sewer was removed entirely and a heavy wooden box, 12x18 in., was constructed under the bottom slab. The ordinary flow of the 4x5 ft. was carried through this box, leaving the trench dry for the concrete construction. At the time the concrete siphon was completed, the 14-ft. sewer westward had been finished as far as Parnell St., and the 4x5 ft. had been turned in at that point. Its flow now follows its permanent course through the siphon and the drain and into the old sewer at 23rd St. The temporary wooden box and the portion of the old sewer above the drain have been sealed and concreted.

Fig. 6 is a view looking into the siphon from the sewer, showing the sloping roof and the curved end of the partition wall. In the design of the siphon the capacity was compiled from Kutter's formula for 2090 cu. ft. per sec. on the hydraulic gradient. On account of the length and shape of the reducers the loss of head at entrance and exit will be negligible. The concrete sections were designed for the earth load and pavement and for combinations of 10-ton rollers. The dead load is everywhere sufficient to overbalance the upward pressure of the water. Two types of section are used, the lighter one being under the greater fill, where the excessive live-loads have little effect. The contract cost of the siphon is given in Table II.

TABLE II. COST OF CONCRETE BOX SECTION OF ROCKY BRANCH JOINT DISTRICT SEWER ON PALM ST., ST. LOUIS, MO. (757 FT.)

Started June 17, 1913.			Completed Nov. 17, 1913.
Class "B" excavation between lumber; sheathed and braced banks (10-in. brick pavement).	685.81 cu.yd.	$4.60	$3,154.73
Class "B" excavation between sheathing left in place (old 4x5-ft. sewer removed)	217.93 cu.yd.	4.00	871.72
Class "C" excavation between sheathing left in place	11,213.60 cu.yd.	2.00	22,427.20
Class "A" concrete	4,249.82 cu.yd.	10.00	42,498.20
Common brick masonry (bulkhead at old 4x5-ft. sewer)	5.50 cu.yd.	11.00	60.50
1-in. reinforcing steel bars	32,447.00 lin.ft.	0.09	2,920.23
¾-in. reinforcing steel bars	40,946.24 lin.ft.	0.07	2,866.24
⅝-in. reinforcing steel bars	69,134.98 lin.ft.	0.06	4,148.10
½-in. reinforcing steel bars	28,502.49 lin.ft.	0.03	855.07
Lumber left in trench	158.007 M. ft. b.m.	35.00	5,530.25
Total cost			$85,332.24
Cost per lin.ft.			$112.72
Total engineering and inspection for five months			1.41%
Work started			June 17, 1913
Work completed			Nov. 17, 1913
Actual time concreting			3½ months.

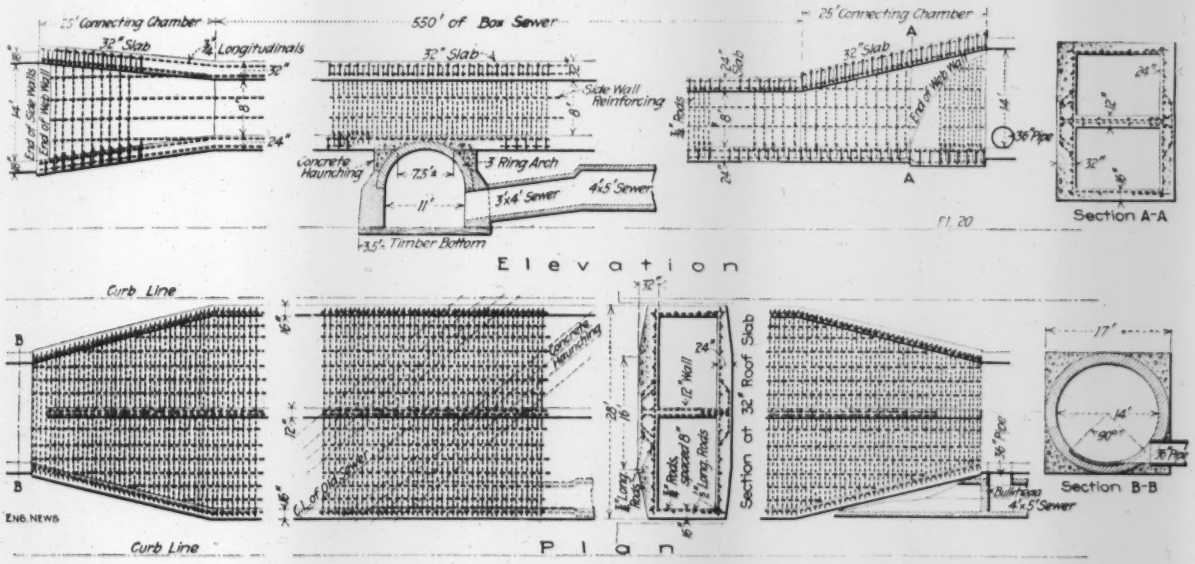


FIG. 5. REINFORCED-CONCRETE SIPHON IN SEWER

CONTINUATION OF RELIEF SEWER

From the concrete siphon, the 14-ft. brick sewer continues eastward, intercepting a 2x3-ft. sewer at 19th St., while a 2½x3½-ft. sewer in 21st St. is carried over the top of the relief without interference. Where the sewer turns north on Blair Ave., toward its outlet, the grade was increased to 1½% in order to keep below ground. Advantage is taken of this change to reduce the size from 14-ft. to 10-ft. diameter, but about 100 ft. of the large size is built on the steep grade to allow an increase in velocity before the area is cut down.

TUMBLING BASIN—Within 100 ft. of the old sewer, the crown of the arch comes within 4 ft. of the surface, and here a direct drop of 12 ft. is made in a tumbling basin of special construction, and the flow then enters the old sewer just at the upper end of the enlarged section already described.

This chamber and the connection to the old sewer are shown in detail in Fig. 7. As practically the whole stream will impinge against the wall of the chamber, the construction was made very heavy, and the whole chamber is made of vitrified brick with granite facings. In order to reduce the wear and to leave the structure free for entrance the ordinary flow is carried through a 24-in. drop pipe set in concrete. The intersection of the old and new sewers was made as acute as possible in order to utilize the high velocity of the effluent from the relief sewer.

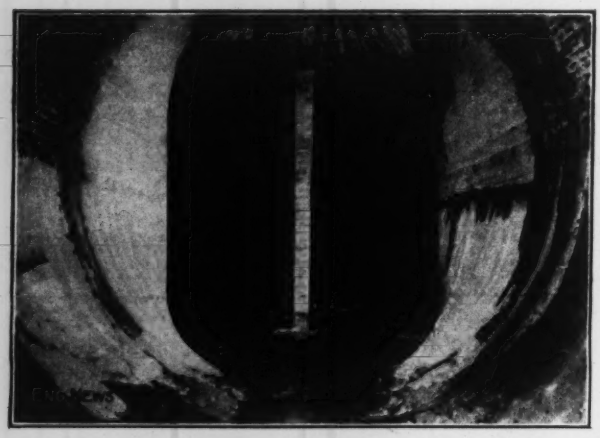


FIG. 6. INTERIOR OF REINFORCED-CONCRETE SIPHON

(The vertical wall in the center is the end of the partition or web wall of the siphon. In the foreground is the horse-shoe sewer, with tapering connection to the rectangular double-chamber siphon.)

By Jan. 1, 1914, the relief sewer was practically complete from its outlet to Jefferson Ave., and it is under construction at the latter point and at a point on Glasgow Ave. Unless additional difficulty develops it will be in service before the sumer storms occur. Owing to the high level of the lower part of this sewer, the wet sand was avoided except in the tumbling basin and the short portion of deep sewer below it, where some sheeting and a heavy concrete cradle had to be used. At the west end, near Jefferson Ave., a great deal of water and fine sand was encountered, and driven sheeting is now being used.

Owing to the location of the work, the cost is, of course, much greater than that of similar new work in the outlying districts. All surplus excavation, over half of the total, and practically all that for the concrete siphon, had to be hauled about a mile. The prices for excavation also include the cost of relaying the brick street pavement with concrete base for the whole length, except the block on Blair Ave.; and in addition, as the work is paid for by special taxation, the interest, discount and collection on the tax bills must be taken into account. The total cost of this contract will be about $460,000. With the $111,000 for the enlargement, this makes the cost $570,000 for about 100% increase in capacity, against a cost in 1860 to 1875 of about $256,000 for the original work.

This work was built under the direction of C. A. Moreno, Sewer Commissioner, and James A. Hooke, Assistant Sewer Commissioner. The detailed plans were made by P. J. Markmann, Office Engineer, and Mr. Chivvis, Assistant Engineer. C. S. Butts has been in immediate charge of construction. The writer is Principal Assistant Engineer in the Sewer Department of the city of St. Louis.

The Status of Wireless Telegraph systems in the United States in 1907 and 1912 has been recently reported by preliminary figures of the U. S. Bureau of the Census as shown by the accompanying table (commercial plants only). The report of one company in the hands of receivers is not included. The figures show a net deficit in 1907 and a net income in 1912; a large plant of the gross-income increase was due to rental of apparatus for ships. The decrease in assets is due to the disappearance of one large company in a merger of interests.

	1912	Per cent. of increase 1907-1912
Number of companies or systems	4	—20.0
Number of messages	285,091	84.4
Number of tower stations	74	—36.8
Income, total	$660,158	526.6
Expenses, total	664,420	314.4
General operation and maintenance	588,712	401.1
Interest and taxes	7,826	40.7
All other expenses	67,882	82.1
Balance sheet:		
Assets, total	$10,377,197	—68.5
Construction, equipment, real estate	1,205,770	279.6
Cash and current assets	9,171,427	—74.5
Liabilities, total	10,377,197	—68.5
Capital stock	9,602,570	—70.6
Floating debt and mortgages	18,483	50.2
Accounts payable	583,160	137.5
Profit and loss surplus	172,984	
Average number employees	958	444.3
Salaries and wages	$393,606	381.4

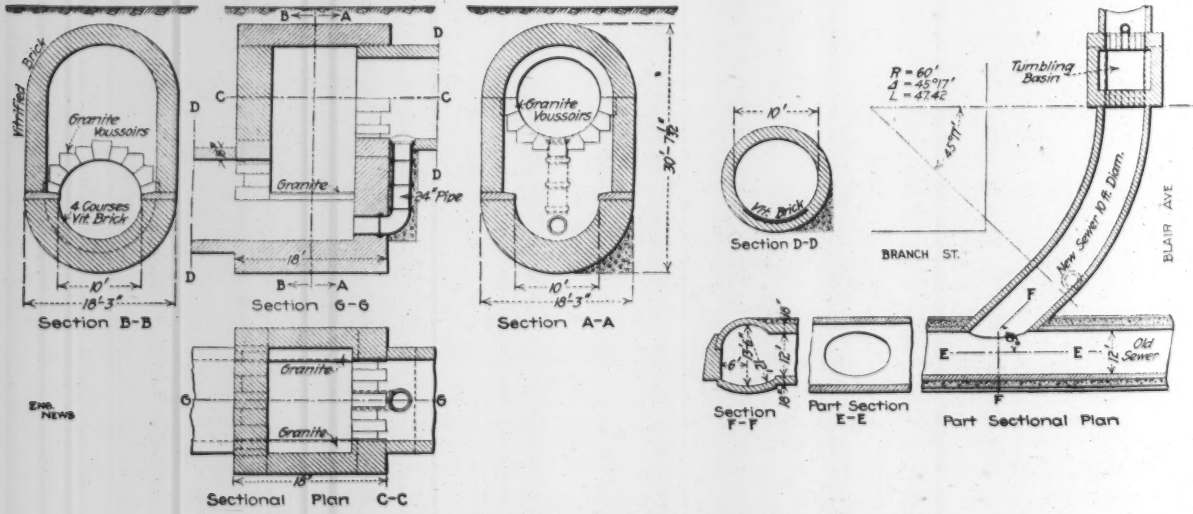


FIG. 7. TUMBLING CHAMBER OR VERTICAL DROP IN SEWER

Valuation for Rate Making

DISCUSSION BEFORE THE AMERICAN SOCIETY OF CIVIL ENGINEERS

The discussions of a Valuation Committee report at a special meeting of the American Society of Civil Engineers, in New York City, Apr. 2, 1914, were reported in ENGINEERING NEWS, Apr. 9, 1914. Space was there given to the criticisms heard. In addition, a written discussion was presented from Charles Hansel (Consulting Engineer, New York City). He criticized the Committee for taking up economic questions of valuation and rates, holding that what was needed and asked for was a review of engineering methods of appraisal. He would have them study the new federal railway valuation act and report on the engineering practice required to conform with it—without attention to the use of the valuation results. He emphasized the complexity of railway tariffs and claimed a fundamental error in basing rates on value.

COMMITTEE'S REPLIES TO CRITICISMS

Among the members of the Committee present were F. P. Stearns (Chairman), Alfred Noble and J. P. Snow. Mr. Snow first took the floor to controvert the idea that the Committee should not have discussed valuation for rate making. He thought the propriety complete, in view of the recent papers of C. E. Grunsky and W. J. Wilgus, both of which looked to valuation for rate-making. He made various citations to the effect that in rate cases, the most important factor to be determined was the value of the property. He opposed the proposition that valuation should not be a factor in railroad rates (not detailed tariffs).

Mr. Stearns spoke on this point also, emphasizing that throughout the Committee's report "rates" were not used in the sense of "tariffs."

Regarding the apparent deference to court opinions, Mr. Stearns called attention to the high character and broad training of the federal bench, particularly the Supreme Court, and contended that when an opinion like that of the Knoxville Water Case had been consistently followed for several years, and was a logical application of recognized legal and economic principles, it must be given the greatest weight, especially since provisions for depreciation and a basis of rates could be formulated in harmony. He contended that all those who strenuously advocated the use of value new as the basis of rates with accompanying small allowances for depreciation, on coming into court would find that they would have that small provision for depreciation used with a diminished value. Mr. Stearns replied to arguments for complete consistency in the use of the property items as they stand today with present prices, or else the property items as they have been built up through the years past with the unit costs of the proper period; original prices were as uncertain as the original complete costs of a plant, while the use of prevailing unit prices was made necessary by court decisions and could be defended on the grounds of custom. Any possible increment, due to rising prices, was not an "unearned increment," since the owner carried also the risk of a decrement with falling prices. He cited numerous works to show the injustice to utility concerns by neglecting the influence of changed conditions, and pointed out that some of the members argued for a consultation of history when it resulted in an increment of value, and against it when it resulted in a decrement.

In reply to those who demanded use of reproduction value new, as the rate-basis worth, he referred to his remarks of Mar. 11, wherein he discussed the necessity of always associating with this basis the proposition to use the smaller depreciation allowances of the sinking-fund method. He referred to the remarks of some who realized this but who objected to any mention of a decreased worth because of the possibility of misapplication. He replied that if any rate-making bodies showed the habit of such illogical and unfair methods it must be because those who had discussed the principles of depreciation before them had not clearly discriminated between the cases where value new or depreciated worth could be used. If that were so, all the more was there need of a proper demonstration of true principles.

In response to the criticism that the Committee's scheme of repayment of capital to offset depreciation would mean a "constant flux of securities," he replied that these allowances would be invested in property extensions in exactly the same manner as the depreciation annuities of the sinking-fund scheme, following the custom of practically all public utilities of the present day, or that it could be temporarily invested in other ways as in the case of a true sinking fund.

Mr. Stearns frankly stated that the Committee did not believe that the railways were securing ample allowances out of rates for the depreciation of their property, and contended that if the Committee plan was followed they would secure this. Meeting depreciation as a part of maintenance or by the sinking-fund procedure, might be easier for the engineers than that proposed, but they were open to more serious objections than any brought against the Committee's plan. There was the great objection, in one case, that funds must be kept intact for years; in the other case, the larger items of replacement, such as terminals, would put burdens on those who had not used up the property. He prophesied that "value of service" would not be the future basis of rates, and that ability for continued use or original efficiency would not be grounds for calling plant value 100% its original figure.

Mr. Stearns read a brief statement for Alfred Noble, in which he advocated further discussions of the subject and expressed the openmindedness of the Committee. Nevertheless, he felt that the criticisms, which were largely confined to the section on depreciation, were due to misunderstanding of the plan. He asked more careful examination of the report and expressed confidence in its just treatment of all.

Land-Drainage Pumping Plants operated by gas and oil engines are being introduced to supplement the old steam-engine plants in the land-drainage work in the "Fens" or marsh lands along the east coast of England. The district covers about 32,000 acres, and for drainage purposes is under the control of two local bodies or "trusts," with 30,000 and 2000 acres each. All streams and drainage ditches have levees to prevent overflow, and the water is raised and discharged into outlet canals. The larger "trust" has a pair of beam engines of 60 and 80 hp., installed in 1825 and rebuilt in 1883, each operating scoop waterwheels 20 ft. diameter, lifting the water about 4 ft. to the canal. These are to be supplemented by two Diesel engines of 50 hp., each driving a centrifugal pump. The smaller "trust" had a single beam engine and waterwheel, but the engine has been replaced by a 50-hp. Tangye gas engine and suction gas-producer plant.

Passing of the Providence Counterweight Cable Road

An old and interesting piece of engineering construction, the Bronsdon counterweight cable road in Providence, R. I., is soon to be torn up, being superseded by the street-railway tunnel described in ENGINEERING NEWS of last week. This short stretch of cable road has been used in its present form since 1896 for assisting electric cars up a very steep grade. Wide interest has always been shown in the road; a few inquiries regarding it continue to come to us and more to the railway officials, even from distant parts of the world. The accompanying figures have been arranged, by [illegible] courtesy of H. W. Sanborn, Chief Engineer, from the [illegible] truction drawings preserved by the Rhode Island C[illegible] accessor to the Union R.R. Co., by which the sche[illegible] was installed.

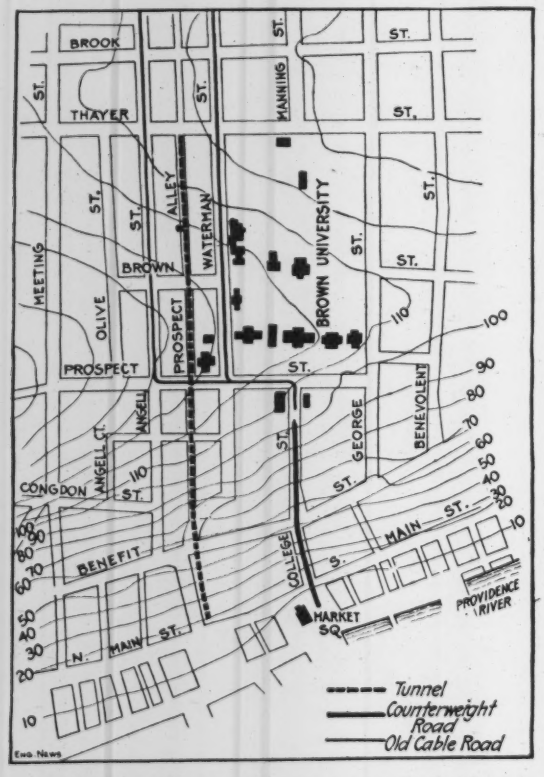


FIG. 1. SKETCH MAP OF PROVIDENCE, R. I., SHOWING LOCATION OF OLD CABLE LINES, EXISTING COUNTERWEIGHT ROAD AND EAST SIDE TUNNEL

The chief residential section of the city i[illegible]ated on a hill, about 125 ft. high, which rises on a [illegible] grade from the easterly part of the business distri[illegible]d then slopes off gently to the Seekonk River, a d[illegible]ance of about 1½ miles. Many of the finest reside[illegible] of the city are situated on this hill, as well as the b[illegible]ings of Brown University (whence the name "Colle[illegible] Hill"). Growth of the city easterly and northeasteri[illegible] has progressed steadily. The ascent from the west ca[illegible] be made on a 12 to 16% grade by automobiles and light t[illegible]ms, but heavy teams must follow the easy slope around the southern and eastern side to the top.

About 25 years ago horse cars were driven to the foot of the slope and then operated as cable cars over the hill and to the river; later, when electric operation was introduced, this counterweight cable system was constructed, by means of which the cars are still lifted up the steepest part of the grade, a distance of about two city blocks. It was soon felt that this arrangement did not wholly solve the difficulty, as the cars are necessarily small and the operation slow, so for many years the problem of a direct, rapid and safe approach to the east side continued to be discussed, and in this time over forty different plans were presented. The two most popular were a graded-highway viaduct and a tunnel for street cars only.

It was at first announced, when the change from cable to electric working was undertaken (ENGINEERING NEWS, Oct. 11, 1894), that the counterweight system of J. P. F. Kuhlmann would be installed, patterned after construction in successful operation at Portland, Ore. This line (as described in ENGINEERING NEWS, June 29, 1893) had a shallow conduit on the roof of which were the running rails. Below was a narrow-gage track on which ran a 6½-ton counterweight truck. The cable from the counterweight carriage ran up to the end of the conduit, over a sheave and came out into a small slotted duct between the main running rails. A car gripped the upper cable and in descending raised the weights. When the counterweight carriage reached the upper end of its travel, the narrow-gage track became level so that the weight

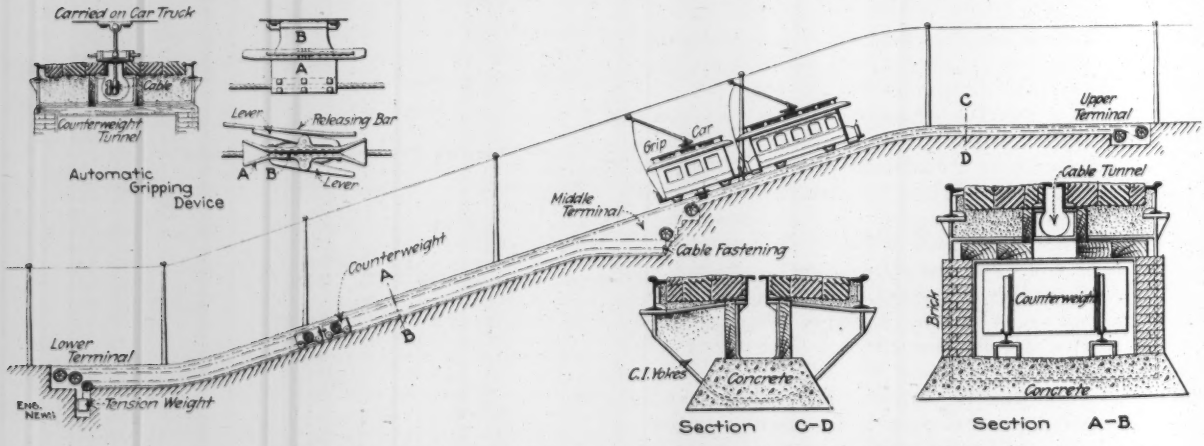


FIG. 2. DIAGRAM SHOWING SCHEME OF PROVIDENCE COUNTERWEIGHT ROAD

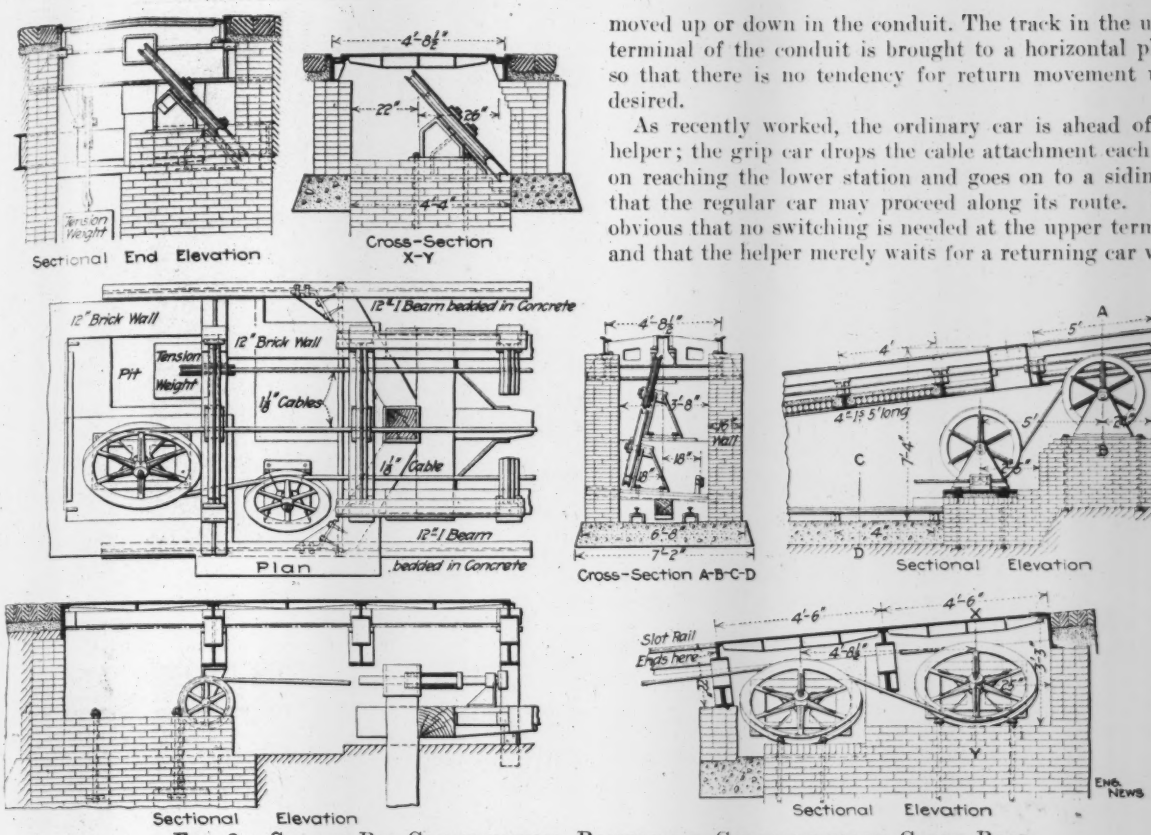


FIG. 3. SHEAVE-PIT CONSTRUCTION, PROVIDENCE COUNTERWEIGHT CABLE ROAD

would stay in its elevated position until the grip was picked up by an ascending car, which was helped up by the downcoming weight. All power was furnished by the car motors and the cars had to alternate in direction.

The system actually installed in Providence, however, was devised by M. H. Bronsdon, of San Francisco, Calif., then chief engineer of the Union R.R. Co. and later of its successor, the Rhode Island Co. The Bronsdon system bears little resemblance to the Kulhmann scheme beyond having a counterweight running in a conduit; the design was patented but the patents expired in 1912. Fig. 2 shows the arrangement diagrammatically.

By running the cable over sheaves on the counterweight carriage, the car travel is made twice that of the counterweight carriage, which then requires a shorter conduit. The cable is not continuous and desired tension is automatically maintained by a weight at the end in the lower pit. There is a fixed grip on the upper section of cable (which runs under a central slot) and this is engaged by alternate descending and ascending cars. The grip car is used as an auxiliary so that any type or length of car may be operated over the hill without having special attachments.

The grip, as shown in Fig. 2, is in two parts, the lower half *A* being fastened permanently to the cable, while the upper part *B* is fastened permanently to the grip car. The lower part is automatically released from the upper part at the lower terminal. The part carried by the grip car pushes aside one of the two ratchet hooks on the cable attachment and engages with the other. By releasing brakes or applying power, depending on whether the car is descending or ascending, the counterweights are moved up or down in the conduit. The track in the upper terminal of the conduit is brought to a horizontal plane, so that there is no tendency for return movement until desired.

As recently worked, the ordinary car is ahead of the helper; the grip car drops the cable attachment each trip on reaching the lower station and goes on to a siding so that the regular car may proceed along its route. It is obvious that no switching is needed at the upper terminal and that the helper merely waits for a returning car without taking a siding or releasing its grip. The motors under the cars supply the power for operation, the intention of the counterweights being to balance the car weight and bring it under the same operating conditions as when running on level. In the 18 years of operation there has been no serious accident on this line, though the counterweight is reported to have come down ahead of its schedule on a few occasions. As many as 42 cars have been run per hour each way over the double-track installation here.

Figures for Ocean-Cable Systems of the United States (commercial) are reported in a preliminary bulletin of the U. S. Bureau of the Census just issued for 1912. The data are given in the accompanying table. The mileage of cables is the entire owned or leased length wherever located; and the statistics involve some foreign operations. Statistics for the two foreign companies having cables landing in this country are not included.

	1912	Per cent. of increase 1907-1912
Number of companies or systems	7	.....
Nautical miles of ocean cable	67,676	46.2
Number of messages	5,841,280	—0.5
Income, total	$8,469,374	10.4
Expenses, total	5,516,527	51.4
Operation and maintenance	4,008,218	81.8
Interest and taxes	1,214,554	2.0
All other expenses	293,755	18.7
Balance sheet:		
Assets, total	$107,583,155	12.5
Construction, equipment, real estate	78,136,115	0.9
Stocks and bonds	16,811,087	29.6
Cash and current assets	12,635,953	142.3
Liabilities, total	107,583,155	12.5
Stock, debt and reserves	99,049,851	10.8
Accounts payable, sundries, etc	2,047,026	—26.2
Profit and loss surplus	6,497,278	85.8
Employees—average number	1,656	37.2
Salaries and wages	$1,167,014	27.5

Special Steel Sash, Hill Building, New York City

SYNOPSIS—Full office-building requirements met with steel sash. Forced ventilation and humidity control in the building require windows to be tight. Good appearance and great strength demanded. Panels 11½x11½ and 11½ ft. x 18 ft. 10 in. Vertically pivoted section in each panel, normally locked.

Special requirements in window arrangement in the new printing house of the Hill Publishing Co., Tenth Ave. and 36th St., New York City, led to the development of special metal sash. The "United Steel Sash" of the Trussed Concrete Steel Co., Youngstown, Ohio, were taken as basis, and by various modifications the particular demands of owner and architect were met. The view Fig. 1 and the drawing Fig. 2, show the regular panel; three-quarters of the window area in the building consists of such panels.

Many adaptations of steel sash to factory uses have developed factory sash quite fully. In the last few years there has been considerable demand for high-grade sash construction, meeting office-building standards in tightness, accuracy of fit, strength and appearance. The Hill Building installation represents further progress in this direction. While factory sash are sold at prices as low as 20c. per sq.ft. in some cases, about 78c. per sq.ft.* was paid for the 37,000 sq.ft. of window in this building.

The chief requirements were: Large panels (regular 11½x11½ ft.; special, up to 11½x18 ft. 10 in., with semicircular top); maximum glass area; complete weather-tightness, not only for water but also for air; unusual strength in spite of the large size of panel and the desirability of avoiding light-reducing mullions; good appearance inside and outside; sash normally fixed or locked, but with provision for passage of window-cleaners; puttyless glazing.

The ventilating system of the building is a balanced air-supply-and-exhaust system, which is intended also to assure humidity control, as required for fine printing. Open windows would interfere with the working of the system. A swing section is provided in each panel, and is fastened with buttons turned by special key.

Special Elements of Strength—Referring to the drawing, Fig. 2, the regular panel is seen to be made up of 14x22-in. lights arranged to form five fixed and one swing section, divided by one horizontal and two vertical mullions. The rails and stiles of the separate sections are made of an unusually deep channel-shaped bar, giving great strength to the sections; the strength of the panel as a whole, however, depends on the mullions.

The horizontal mullion bar, between upper and lower groups of sections, extends unbroken across the panel, and its ends are seated in the masonry. Its bending strength is due to a plate web, 4 in. deeep (bar K, Fig. 3) made integral with the sash rails seated against it, by through bolts. The vertical mullions, which are interrupted at the horizontal mullion and are supported by it, are formed by the channel stiles of the adjacent sections in conjunction with inner and outer 2x¼-in. steel plates, all clamped together by bolts through the plates. Spreader pieces between the two stiles insure correct spacing of the units. The bolts have both head and nut countersunk and slotted for screwdriver.

*Not including glazing or cast-iron sills. Glazing adds 26c. per sq.ft.

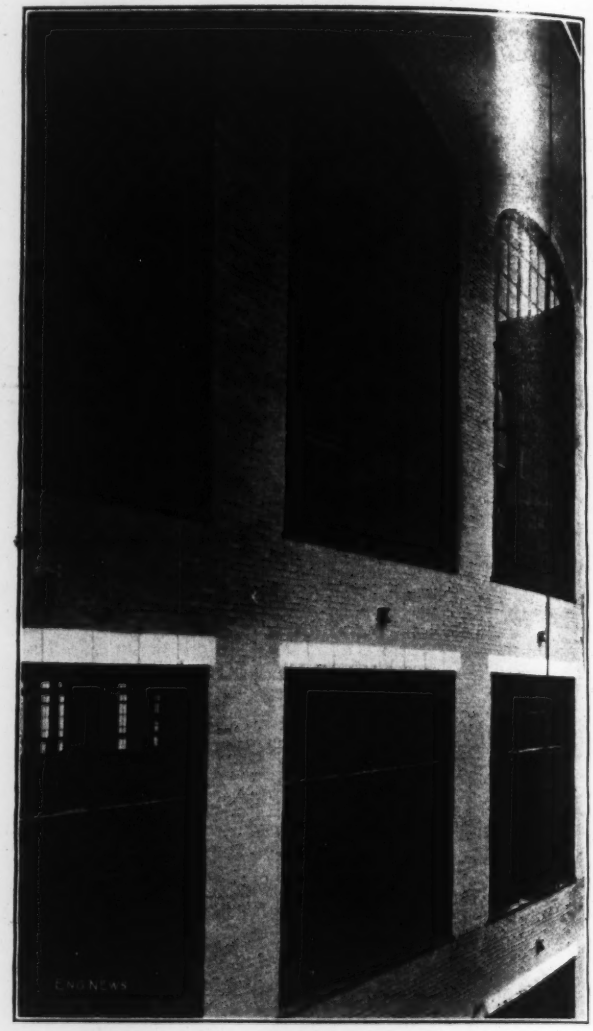
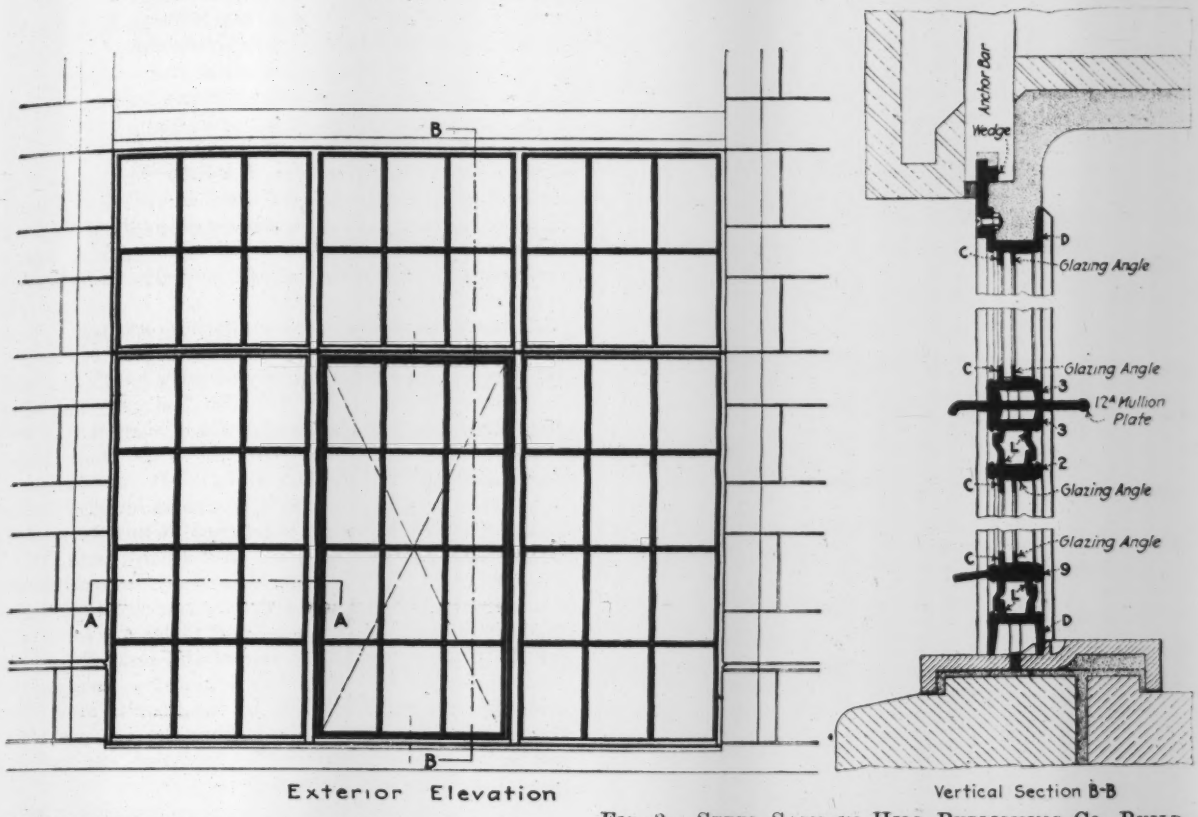


Fig. 1. Panel of Steel Sash, Hill Bldg., Tenth Ave. and 36th St., New York City
(Regular 11½x11½-ft. panel, 11th story; 11½x18-ft. 10-in. panel, 12th story.)

Jamb Plate—To give good mechanical connection and seal between sash and masonry, the panel is edged with a 2x¼-in. plate bolted to the stiles and lintel rail. As Fig. 2 shows, this plate engages forked plate-anchors, built in the masonry about 18 in. apart, and is keyed in by steel wedges. This arrangement leaves a seal-space of ¼ to ½ in. between back of terra cotta and front of edging plate, which joint is sealed with oakum rope and mortar pointing. The brickwork is set back far enough to permit of surrounding the edging plate with mortar at the back, where the interior plastering is carried against the sash frame.

The edging plate also enhances the appearance of the panel. In conjunction with the 2-in. plate fronts of the mullions, it produces a bordered panel effect as may be seen in Fig. 2, without reducing the glass area.

Vertical-Pivot Swing Sections—The narrow and high swing sections naturally called for vertical pivoting, whereas horizontal pivoting is customary in steel



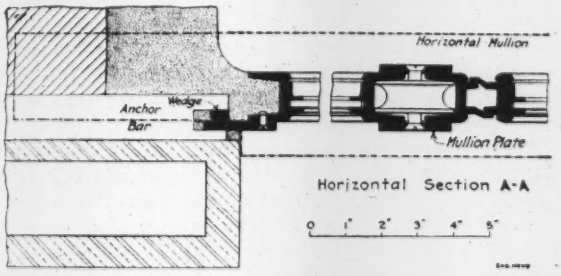


FIG. 2. STEEL SASH IN HILL PUBLISHING CO. BUILDING; STANDARD 11½x11½-FT. PANEL (14x22-in. plate-glass lights.)

sash. The half-round rabbet rails used in "United" swing sash were not considered satisfactory for this case, and a special flat-lip bar was made (bar L, Fig. 3) from bar 6, Fig. 3, by bending the longer leg to an offset; thus a double set of flat seating surfaces was obtained without displacing the sash out of the general plane of the panel. On account of the vertical pivoting, the rabbet edges of the stiles are straight and unbroken the full height of the section, and thus the important vertical lines are preserved. The break in the horizontal lines at upper and lower rabbet rails in passing the pivots is not noticeable. The steel pivots (fitted with bronze pins) completely fill and seal the break between left and right rabbet rails.

Four simple turn buttons in the stiles fasten the swing section; they are located near upper and lower corners. Their center pins project through a shallow boss on the inner face of the stile and bear a slotted head with interrupted slot, requiring a special key for opening.

GLAZING ANGLE—The glass is seated inside the stops, against a thin bedding layer of "steel sash putty." A novel form of fastening was devised, in place of the usual spring clips. The glass is retained by a ⅜x½-in. glazing angle continuous around the edge. This angle is formed out of the rolled angle-bar by notching a length equal to the periphery of the light, at three points corresponding to the corners, and mitering the ends; then bending to right angles at the notches. The one open corner gives perfect adjustment of the angle strip to the side of the stop (Fig. 4). To hold the angle, tee-point "screws" are used. These are small T-bolts formed with an oval head slotted for screwdriver. Slots in angle-strip and stop-strip enable the T-point to pass through, and a quarter turn then locks the fastening securely, the T-lugs being slightly beveled. As the slot in the angle-strip is vertical and that in the stop-strip is horizontal, adjustment in both directions is secured.

FINISH OF SASH TO OPENING—On the outside the window panel seats close against the inner edge of the terra cotta facing in the reveal. On the inside, at jamb and lintel the wall and ceiling plaster is carried around

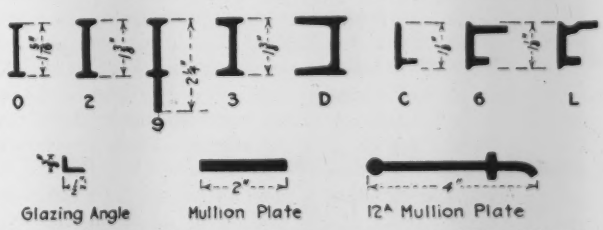


FIG. 3. BARS USED IN CONSTRUCTION OF HILL BUILDING STEEL SASH

the reveal and brought in against the edging plate, with a cove of 1-in. radius.

A cast-iron sill forms the seat for the bottom of the panel. The outer edge of the sill turns down over the brickwork to the terra cotta of the ledge. Along the inside of the sash a drain groove is formed in the sill to collect condensation.

CONSTRUCTION—As in the regular "United" sash, the members are formed of narrow seating or stop bars and deeper assemblage bars flanged at the edges; and the flanges are forced tight over the edges of the stop bars under a heavy press. The separate bars used in the present sash are shown in Fig. 3; in Fig. 2, the designating numbers of the bars are noted.

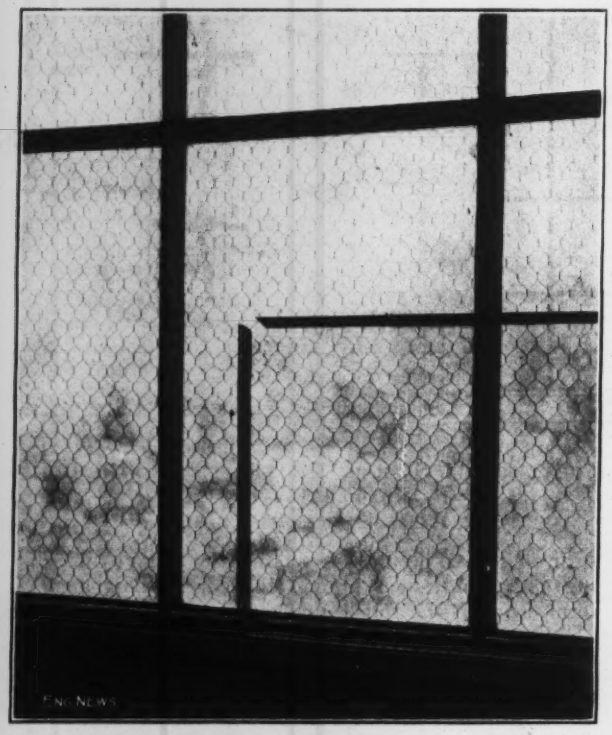


FIG. 4. DETAIL VIEW OF STEEL SASH IN HILL BUILDING, SHOWING ½x⅜-IN. GLAZING ANGLE

Bar 2 is used as assemblage bar for the vertical muntins, while bar O, a trifle less deep, is used in the horizontal muntins. The shallower bars fit between the flanges of the No. 2 bars, and become fixed in position when the latter are "wired" over (flanges pressed down). The rails and stiles of the separate sash sections are similarly formed by assembling channel-shaped frame bar *D* with stop or seating bar *C*, the latter being held by having the edging lugs of the channel bars "wired" over. This method of connection unites the members of a composite bar into a firm assemblage.

In assembling these sash, the C-bar (see Fig. 3) which forms the seat for the lights was cut to the length of the periphery of the light, notched, mitered and bent up, as above described for the glazing angles. Then the miter joint was closed by oxyacetylene flame welding. (In usual practice, the C-bars are notched for all four corners, and the ends butted at the middle of one side, leaving the joint open; but for this building a tight job was required, which led to the modified method as d[illegible]ed.) A vertical row of such C-frames was set togeth[illegible]th 14-in. lengths of the O-bars in place between the[illegible]n the press the edges of the O-bars wired over, ass[illegible]ng the row. Placing side by side the necessary num[illegible]of such rows, together with No. 2 bars, of length [illegible] to the height of the sash section, and with rails and [illegible] in position around the outer edge, the entire secti[illegible] has assembled was put through the press and all fla[illegible] or lug edges wired over. Finally, the corner joints o[illegible]ils and stiles were welded by oxyacetylene flame (the[illegible] corners are ordinarily tenoned, and not welded). The finished sash thus has no open joints.

KINDS OF WINDOW PANEL—Both street fronts of the building have two narrow windows in each corner bay, but otherwise are fitted entirely with the panels of Fig. 2, from second floor to twelfth. The first story has plate-glass store fronts. The twelfth (top) story is of double height, with a mezzanine along the street fronts but of clear 23-ft. ceiling height in a 50x120-ft. area facing the light court on the north side of the building. Window panels 11½x18 ft. 10 in., were used in this story on the street fronts and the main wall of the light court. On the street fronts, these high panels are used for architectural reasons only. The floor of the mezzanine abuts against them at midheight, and here steel plates are substituted for the glass lights in one tier of the sash; the I-beam joist of the mezzanine is close behind the sash, and the 6-in. concrete surfacing slab of the floor is brought up tight against the steel plates. Thus the windows of the mezzanine extend down to the floor line, the radiators serving as guards.

On the north wall, on the light court, high windows of the same size (11½x18 ft.) are used, but their tops are semicircular, to match the groined-arch effect of the suspended ceiling (Fig. 1). In one bay of this wall, however, a fire-escape door takes the place of one of the lower sections of the window.

FIRE-ESCAPE DOORS—These doors are of almost precisely the same construction as the windows, and are full-glazed down to within 6 in. of the floor (with a steel plate below). The latch stile is heavier than the other framing members. A panic-bolt latch fastens the door, opened by outward pressure on the bar of the latch. The door is hinged by trunnions in upper and lower rails.

GLAZING—The entire building is glazed with ¼-in. plate-glass. On the street fronts, clear polished plate is used; on the light-court, on the north side of the building, polished Mississippi wire-glass; and in the toilet rooms, Florentine wire-glass.

PAINT—All sash received a shop coat of "Bar-ox" paint, by dipping. The same paint was subsequently adopted for all the ornamental iron in the building, because of its fluidity.

WEIGHT OF SASH—To complete the comparison of this sash installation with steel sash made under usual "United" practice, the weights must be noted. Heavier sections are used in the present sash than customary for equivalent panel sizes. This, together with the modifications previously described, makes the Hill Building sash weigh about 7 lb. per sq.ft. For comparison, T. H. Kane, Works Manager of the Trussed Concrete Steel Co.'s Youngstown sash plant, states that "United" sash as usually made weigh about 4 to 5 lb. per sq.ft. All these weights are for steel alone.

The large increase in cost, however, previously noted, is due also to a higher grade of workmanship in manufacture, necessitated by the rigid service requirements.

Typhoid and Paratyphoid along the Richelieu River

By Theo. J. Lafreniere*

During January and February, outbreaks of typhoid and paratyphoid fever occurred in 10 of the 14 municipalities bordering the Richelieu River. The outbreaks have not been severe, although the number of cases has been rather large, the death rate being low for a paratyphoid epidemic. Several cases of true typhoid and paratyphoid have been reported and checked by the agglutination test, but in two municipalities, the symptoms would indicate severe intestinal troubles only.

Paratyphoid is not a reportable disease in the Province of Quebec, and the Board of Health became aware of the conditions along the Richelieu River, through the examination of the water-supply of Chambly Canton. On Feb. 26, complaints were made, that the carcass of a dead animal had been thrown over the water intake of that town, and the inspection revealed that intestinal troubles were prevalent in the town. Inspectors were immediately sent to the various towns bordering the river, above and below Chambly Canton, and it was discovered that in 8 municipalities there had been numerous cases of typhoid and paratyphoid, since January, 1914. The outbreaks having started one and two months before the inspections were made, and the character of the disease being mild, it has been difficult to obtain exact data on the first cases. However, the information secured, given briefly in the table below, shows clearly that the outbreaks have been caused by the river water.

TYPHOID AND PARATYPHOID IN TOWNS ON THE RICHELIEU RIVER, WITH SOURCES OF WATER-SUPPLY

Town	Population, 1911	Cases of Typhoid	Cases of Paratyphoid	Deaths†	Water-supply	Approx. date first case
St. Johns	5900	14	260	3	River	3rd week Dec.
Iberville	1900	.....	60	...	River	3rd week Dec.
Richelieu	330	1	15	...	River	4th week Dec.
Chambly Canton	860	2	20	1	River	4th week Dec.
Chambly Bassin	900	3	25	4	River	4th week Dec.
Beloeil*	1500	.....	.....	...	Springs	4th week Dec.
St. Hilaire	1300	.....	.....	...	Springs	.....
St. Charles	890	a few	35	...	River	2nd and 3rd week Jan.
St. Marc	950	a few	25	...	Springs and river	2nd and 3rd week Jan.
St. Antoine	1400		numerous	...	River	2nd and 3rd week Jan.
St. Denis	730		numerous	2	River	2nd and 3rd week Jan.
St. Ours	620	..	2	...	Springs	.....
St. Roch	820	1	.....	...	Tubular wells	.....
Sorel	8400	8	84	3	River	January

* The Explosive Works, at Beloeil, use river water; 12 cases among employees, 10 cases have been discovered among families having private supplies with intake in the river. † From typhoid and paratyphoid.

St. Johns and Iberville, where the first cases appeared, are situated on each side of the river, and Rouses' Point, 22 miles above, is the first town on the river. Twelve and 18 miles above St. Johns, there are two small towns having no sewerage systems which are connected with the river by small streams flowing into the Richelieu. No typhoid cases occurred in those towns in December, 1913, and January, 1914. One of Iberville's sewer outlets is a very short distance below St. John's water intake, on the other side of the river, and it is possible that frazil ice which forms above the rapids immediately below St. Johns might have caused the sewage from Iberville to flow on the St. Johns side and contaminate the water intake.

During the first week of March, all the municipalities were notified that the water should be boiled, and five towns have already installed temporary plants to treat the water with chloride of lime. The epidemic is now (Mar. 30) under control, and at its next meeting the Board of Health will decide what measures should be taken to prevent similar outbreaks in the future. It is expected that rapid filtration will be required for the largest water-supplies, and chlorination for the others. Paratyphoid will probably be added to the list of reportable diseases.

The water of the Richelieu River has been analyzed repeatedly since 1909, and the results sent to most of the municipalities. The river is contaminated by the sewage of the bordering towns, and above St. Johns, B. Coli is present in 1 c.c. The bacterial count, however, is relatively low.

The powers granted to the Board by the Quebec Public Health Act, of 1900, are not retroactive, and it is necessary to proceed under the general clause for nuisances, which is rather general, to force the older towns to improve their water-supplies. However, no trouble is anticipated from the towns on the Richelieu River.

*Sanitary Engineer, Board of Health of the Province of Quebec, 9 Rue St. Jacques, Montreal, Que.

Municipal Projects at Calgary, Alberta

By Geo. W. Craig*

The City of Calgary is looking forward to a very active season of construction. Although it is not expected that as much will be done this year as perhaps in the year following, yet there are now under way a number of projects that will mean a great deal to the city.

Water-Works—There is now ready for submission to popular vote a project for an entirely new water scheme, bringing the water by gravity from the headwaters of the Elbow River in the Rocky Mountain Timber Reserve. In the design of this scheme, we propose to provide for considerable storage, both at the intake and in reservoirs near the city limits. The capacity of this plant will be approximately 60,000,000 gal. U. S. per 24 hours, with storage capacity in the neighborhood of 1,200,000,000 to 1,800,000,000 U. S. gal.

Sewage Treatment—Plans are being prepared for a sewage-disposal plant to take care of all the sewage of Calgary. The probabilities are that this plant will employ sedimentation and coarse filtration, making use of two-story tanks and sprinkling filters. Provision is being made for a plant of several units, the first unit to take care of 100,000 population.

Bridges—Three bridges are projected. The high-level bridge proposed two years ago was by an action in Court temporarily abandoned, but a new proposition is to go before the people within the next few weeks calling for what may still be termed a high-level bridge. The estimated cost of this bridge is $330,000. Another bridge will be built across the Elbow River at Fourth Street West. This is known as the Mission Bridge. It will be of reinforced concrete and will probably cost about $80,-

*City Engineer, Calgary, Alberta.

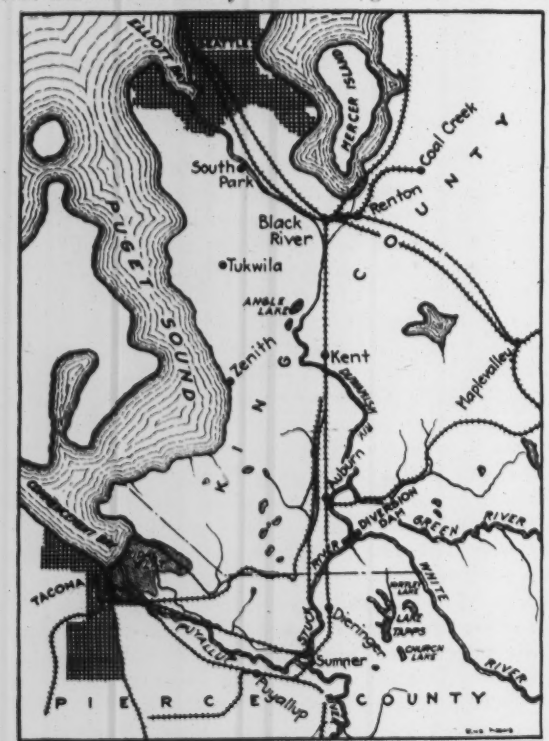
000. A second bridge will be built across the Bow River. This will be of steel, as it will parallel the present steel structure, and will be similar in design. The present bridge, while comparatively new and in first-class condition, is not sufficiently wide to take care of the traffic. The purpose is to take care of the north-bound traffic on the new bridge and the south-bound traffic on the old structure—making what might be termed twin bridges.

TUNNELS—Plans are prepared, and will be carried out during the season, for the construction of two tunnels under the Bow River. These tunnels are so designed to take care of inverted siphons for sewage and for water, besides telephone and electric cables.

ELECTRIC POWER PLANT—An extension to the city power plant is being completed, using turbo-generators of large capacity. This extension will give a total capacity of about 20,000 kw.

A River Diversion Project for the Puyallup and Duwamish Rivers, Washington

For a number of years, the cities of Tacoma and Seattle, Wash., have been subjected to floods which, rising in the Cascade Mountains, came down the White River to a point near the boundary line of King and Pierce Counties where, depending upon the conditions, the excess flow of water would pass either down the Puyallup Valley to Tacoma, or down the Duwamish Valley to Seattle. The State legislature of 1913 passed a law permitting two or more counties to contract together on improvement for their joint benefit. King and Pierce Counties have taken advantage of this legislation and have agreed upon an expenditure of $250,000 per year for a period of six years for a solution of the flood problem of the two valleys. The main feature of this solution is the construction of a diversion dam which will insure the passage of the waters of the White River down the Puyallup Valley to Tacoma.



MAP OF PIERCE AND KING COUNTIES, WASHINGTON, SHOWING DIVERSION DAM ON WHITE RIVER

The accompanying map shows the geographical conditions. The White River, rising near Mt. Rainier, in its course to the Puget Sound, encountered [illegible] ground which caused it to deposit its carried sand and silt and to build up a bed which at present is some [illegible] ft. above tidewater. While filling up the valley it seems to have alternated in its choice of a route to the sound either the valley of the Duwamish leading into Elliott Bay at Seattle, or a route half as long through the Puyallup Valley to Commencement Bay, at Tacoma. Accumulation of drift, etc., at the juncture of these two valleys tended to throw the flood one way and another. King County spent money to prevent the White River from flowing toward Seattle, whereupon Pierce County brought suit to compel King County to take care of its own flood waters and save the Tacoma end from damage. Bitter feeling was aroused which was only settled by the recent enactment and the ensuing proposed project.

The project consists in the diversion dam built at about the source of the Stuck River and the Duwamish River, at the point indicated on the accompanying map, some five miles southeast of the town of Auburn. The dam will be a concrete structure, partially reinforced, with a top width of 4 ft. 6 in., a bottom width of 10 ft. 7 in., a height of 14 ft., and a length of 1620 ft. Following this work the river from the dam site to Tacoma city limits will be cleared of 25 years of accumulated drift, some of it embedded in the sand, the channel straightened, and the banks protected by suitable construction of a permanent character. Bids are about to be asked for this construction, which will involve 18,100 cu.yd. of excavation, 5840 cu.yd. of concrete, 26,000 lin. ft. of piling. The work is designated officially as Inter-County River Improvement and is under the charge of W. J. Roberts, Chief Engineer, Tacoma, Wash.

The Central Electricity-Supply Industry of the United States has shown general gains for the decade 1902-1912, according to figures recently issued by the U. S. Bureau of the Census. These figures cover both commercial and municipal stations, but do not include isolated factories which consume the current generated, or government and state institutions.

	1912	Per Cent of increase, 1902-1912
Number of stations[1]	5,221	44.2
Commercial	3,659	30.4
Municipal	1,562	91.7
Total income[2]	$302,115,599	252.5
Light, heat, and power, including free service	286,980,858	240.9
All other sources	15,134,741	899.7
Total expenses, including salaries and wages	234,419,478	244.3
Total number of persons employed	79,335	161.6
Total horsepower	7,528,648	308.0
Steam engines and steam turbines:		
Number	7,844	24.6
Horsepower	4,946,532	254.6
Water wheels:		
Number	2,933	111.0
Horsepower	2,471,081	463.6
Gas and oil engines:		
Number	1,116	576.4
Horsepower	111,035	811.5
Kilowatt capacity of dynamos	5,134,689	323.6
Output of stations, kilowatt-hours	11,502,963,006	358.8
Estimated number of lamps wired for service:		
Arc	505,395	31.0
Incandescent and other varieties	76,507,142	320.5
Stationary motors served:		
Number	435,473	330.9
Horsepower capacity	4,130,619	843.1

[1] A single electric station or a number of stations operated under the same ownership.

[2] Exclusive of $36,500,030 in 1912; $20,093,302 in 1907, and $7,703,574 in 1902, reported by street and electric railway companies from sale of electric current.

Editorials

In commenting on the great damage done by the ocean storms to coast resorts near New York, we called attention, in our issue of Jan. 15, to the fact that in only a few cases in this country have the services of engineers been enlisted in the design of coast-protection works. In another part of the present issue an engineer describes beach-protection works, on the groin system, built some years ago under his direction at Asbury Park, N. J., which passed without injury through the recent severe storms. The groin system is well known abroad and its success where it has been properly applied in this country should lead to a larger employment of engineers in connection with shore-protection works.

Uncovering the New Haven Finances

In all the long investigation of the New York, New Haven & Hartford R.R. Co. by State and Federal officials, nothing has occurred better calculated to excite universal public condemnation than the defiance of the authority of Congress and the Interstate Commerce Commission last week by the president of the New Haven National Bank and other officers of the Billard company, a Connecticut corporation, to which some of the lost New Haven millions have been traced.

The Interstate Commerce Commission in its report of its New Haven investigation, made on June 29 last, said:

> The New Haven company has given away of the funds of that company to Mr. Billard and his associates, or to the stockholders of the Billard Co., whatever that may be, between $2,500,000 and $3,000,000 of the property of the New Haven company.

The Commission is now engaged in investigating, in obedience to a Senate resolution adopted on Feb. 7, the question of what became of these and other lost millions of the New Haven company's property. The present management of the New Haven company, under President Howard Elliott, is aiding in every way in this investigation.

In the proceedings before the Commission on Apr. 10, the Treasurer and Assistant Treasurer of the New Haven company testified that officers of the Billard company had duplicate keys to the deposit vaults, in which the New Haven company kept its securities. It was stated further that the Billard stocks had been in the hands of the former president, Charles F. Mellen, and have never been in possession of anybody outside the New Haven company. The New Haven company often furnished cash to the Billard company in return for its notes. Mr. Bowman, Assistant Treasurer of the New Haven company, testified that one of the directors of the Billard company had, about Mar. 1, 1914, taken several packages out of the New Haven vaults, but Mr. Bowman did not know what was contained in these packages and had no knowledge that anybody had checked off the securities thus taken away. The director of the Billard company referred to when placed on the stand admitted that he had removed debenture bonds aggregating $10,400,000 of the New Haven Debenture & Security Co. from the New Haven vaults. He refused, however, to give any information regarding the Billard company or who its officers and stockholders are. The former treasurer of the Billard company, the president of the Merchants National Bank of New Haven and other past and present officers of the Billard company refused to answer any question regarding it and its dealings with the New Haven road.

It will be remembered by those who have followed New Haven affairs that much curiosity was excited some ten or a dozen years ago when it was revealed that the company was engaged in dealings, amounting to many millions of dollars, with J. L. Billard, who had not been heretofore known as a multi-millionaire or as controlling large amounts of capital. Events since that time have changed the feelings of mere curiosity then existing to something much more peremptory than curiosity. The public which relies upon the New Haven R.R. system for railway service and the thousands of holders of the stock and bonds issued by the New Haven road and its subsidiaries have an absolute right to know each and every detail of the transactions which took place between the New Haven company and the Billard company or any other corporation. That the president of a national bank should be a party to the defiance of the Federal government in its endeavor to obtain this information for the public should be sufficient to promptly bring to an end his career in the banking business. Engagement in transactions which are under such a cloud, coupled with the refusal to give any explanation, is sufficient to blast the financial reputation of any man.

Iron Instead of Steel for the Hull of a Lightship

The much debated question of the relative resistance to corrosion of wrought iron and of steel, is brought forward in a paper read before the Liverpool Engineering Society last month describing a new lightship for the Mersey Bar at the entrance to the Liverpool harbor. The author of the paper states that while in recent years the hulls of lightships have been built of steel, in common with those of other vessels, it is yet to be determined whether the use of steel instead of iron is a wise policy. A lightship generally remains on its station for long periods and can only at long intervals be taken to a shipyard for cleaning and painting. Corrosion of the vessel's plates, therefore, is bound to take place and is particularly severe in the neighborhood of the water line. For this reason, while the interior framing of the new vessel is of steel shapes, iron has been used for the hull plates.

An interesting statement bearing on the long life of an iron hull was made by the author. The first iron ship

built in the world was constructed for the Mersey Docks & Harbor Board in 1842 by the famous old firm of Laird Bros., the same firm which during the Civil War built the Confederate cruiser "Alabama." This iron ship was named the "Prince" and was put in service as a light vessel on her completion and was so used until 1899. She was then converted into a wreck watch vessel and is still doing duty in this capacity. It may be recalled that the first proposals to use iron for the hulls of vessels were met with great skepticism, it being urged that such vessels being built of a material heavier than water would certainly sink, or would be at least too heavy and clumsy to make any speed. It was perhaps for this reason that the pioneer iron ship of the world was a lightship intended to remain stationary instead of a vessel intended for voyaging.

The Narrow-Gage Fallacy

A prominent Southern newspaper, in commenting a few weeks ago, on the change of the last narrow-gage railway line in Georgia to standard gage, remarked that while the narrow-gage railway system had outlived its usefulness, it has been of enormous benefit to the world in promoting the construction of pioneer railways under conditions where the expense of a standard-gage railway would not have been permissible.

The old maxims concerning the perpetuity of truth and the vulnerability of error seem strangely at variance sometimes with actual experience. Again and again it has been demonstrated by high engineering authority that the supposed saving in first cost by the narrow-gage railway system of construction had very little basis of fact; and that such saving as might be made would be very quickly swallowed up in increased expenses of operation. Wellington in his monumental treatise on railway location was probably the first to fully and effectively demonstrate the fallacies of the narrow-gage propaganda, and since his time the engineering profession as a whole has, we believe, held sound ideas on this subject; but it is a far cry from the establishment of sound principles in the mind of the engineering profession and the understanding of those principles on the part of the general public.

Even among railway men and financiers, the idea is probably still generally held that the narrow-gage is a cheap type of railway construction. In the recent discussion in Congress over the Alaska railway, there was, we believe, more or less favor shown to the idea of building the system on a narrow gage.

In foreign countries, belief in the narrow-gage fallacy is much more widely disseminated than in this country. While in the United States and Canada the gage question was permanently settled a quarter of a century ago by the universal adoption of the standard gage, partly as the result of the universal interchange of freight cars, in Australia and South America the "battle of the gages" is still in active progress. In the development of the great continents of Asia and Africa too, a great deal of narrow-gage railway is being built at the present time.

It cannot be doubted, therefore, that belief in the economy of the narrow-gage is still widely held, not only by the public, but by many members of the engineering profession in other countries than the United States.

In view of the extent to which American engineers of prominence are extending their interests to other countries during the present dull period in American engineering works, it is not without value to have a renewed discussion of the gage question. Such a discussion appears in the March *Proceedings* of the American Society of Civil Engineers, in which is printed a paper by F. Lavis, which was presented to the Society at its meeting on April 1. Mr. Lavis recently spent considerable time in South America, having been commissioned to make an investigation and report on the question of railway gage as affecting the future development of Argentine. He gives his subject thorough treatment. The paper covers 110 pages of the Society's *Proceedings*. The most important conclusion which he reaches, however, is contained in the following three lines, which we quote from the synopsis which precedes his paper:

COST OF CONSTRUCTION—This is so little more for a railway of 4-ft. 8½-in. gage than for one of 3-ft. or 3-ft. 6-in. gage as to be more than counterbalanced by economy in operation.

This conclusion of Mr. Lavis' is entirely in accord with the opinions of engineers of the greatest experience in railway construction. The popular opinion concerning the low cost of narrow-gage railway construction is doubtless based on the idea that the cost of building a railway varies directly as the gage of its track.

Any engineer accustomed to analyze the elements which enter into the cost of building a mile of railway track perceives at once the falsity in this assumption. Even if it were assumed that the width of cuts and embankments was necessarily increased everywhere by 20½ in. (the difference between the standard-gage track and the 3-ft. gage), the percentage of increase in the volume of a cut or a fill would be extremely small. As for the stock argument for the narrow gage that the narrow-gage locomotives and cars are so light that a light and cheap track is sufficient to carry them, the obvious answer to this is that rolling stock for the standard gage can be made just as light and just as cheap as any narrow-gage cars and locomotives. In fact, one has to go back no long distance in railway history to find just such light cars and light locomotives in use on standard-gage roads. Even in the matter of length and size of ties required to safely carry light rolling stock, the difference in length between a standard-gage and a narrow-gage tie to secure equal stability need by no means be as great as the inches in difference between the gages.

It will probably be admitted even by the most strenuous advocates of the narrow-gage system that if it costs as much to construct as the standard gage, the latter is certainly to be preferred. Aside from other advantages of the standard gage, the fact that it permits an increase in weight of rolling stock and traffic capacity far beyond what is possible with the narrow gage should always turn the tide in its favor even in an isolated location where no question of interchange with other established lines has to be taken into consideration. Probably the only really strong engineering argument that can be brought in favor of the narrow gage is that in exceedingly rough mountainous country considerably sharper curvature can be used. Of course, this is disputed by Wellington and other defenders of the standard gage. Mr. Lavis in his paper just published says:

CURVATURE—Within the limits of the practical operation of railroads any radius of curvature which is feasible on meter gage is as practical on 4-ft. 8½-in. gage lines.

It is entirely true that the great majority of the narrow-gage railway systems of the world are built in country through which a standard gage might have been built on substantially the same alignment. There are, on the other hand, a few narrow-gage roads built in mountainous districts of the Andes and similar broken country where the profuse use of exceedingly sharp curvature undoubtedly saves enormously in construction. It is of course feasible to make standard-gage rolling stock which could pass around such curves, but the train resistance and rail wear involved are materially greater on the standard-gage track than on the 3-ft. gage. We present this merely as the argument of those engineers who still believe in the narrow gage under such special conditions and by no means overlook the fact that there are strong arguments on the other side, such as the increased stability of cars and locomotives negotiating such sharp curves often close to the edge of high precipices.

This matter of stability, indeed, deserves a further word. As the gage of the track is decreased, the variation in the distribution of the load to the two rails due to oscillation of the car on its springs, varying speeds and superelevation on curves, etc., increases very rapidly. Mr. Lavis says that in Argentine it is necessary to rock ballast railways of narrow gage in order to keep them in surface for fast trains. On standard-gage lines, it is quite customary to do without rock ballast. In a country like Argentine, where rock suitable for ballast must all be hauled from a great distance, this item alone represents a great saving by the use of the standard gage, not only in cost of construction but in maintenance.

Even if it were admitted for the sake of argument that on a few railways in the Alps, the Andes, the Himalayas, or similar country, the narrow gage might be preferred to the standard gage, it still remains true that on nine-tenths of the narrow-gage railway mileage of the world, a standard gage might have been adopted in the original construction at no greater first cost and with a saving in operating expenses ever since.

The statistics quoted by Mr. Lavis show that there is in the entire world nearly 165,000 miles of narrow-gage railway lines. The great bulk of this mileage must eventually be converted to standard gage, as the narrow-gage railway lines of the United States have been. The cost of this alteration, enormous as it is, is but a small fraction of the financial loss which the world has suffered, through its belief in this economic and engineering fallacy. A comparison of the freight rates per ton-mile on United States railways and on the narrow-gage railway systems of other countries is most instructive as showing the inefficiency of the narrow-gage system as a transportation machine.

If a fair estimate were made of the cost to the world resulting from the narrow-gage fallacy, the total would probably reach several billions of dollars. The cost in Japan alone of changing 5000 miles of narrow-gage railway to standard gage is estimated at $150,000,000. In Argentine the net earnings of the narrow-gage railways are only about half as much on the capital invested as the net earnings of the standard-gage lines and this, notwithstanding the fact that the capitalization per mile of the standard-gage lines is much heavier.

It is interesting to inquire how the narrow-gage system originated and whether the engineering profession was responsible for leading the world astray on this economic question. The following account is quoted by Mr. Lavis from Geo. L. Fowler.

> The narrow-gage mania which possessed the railroad builders of the United States in the early 70's' was born of the bargain-hunting desire to get something far below its real value. It was just after the Civil War, and hard times were upon the country, yet in spite of this fact, the people over the whole land were clamoring for a more rapid development of the resources than was taking place, and this clamor was especially loud in its demand for an increase of railroad construction, but capital could not be obtained.
>
> It then occurred, to those who were most vitally interested in these constructions, that if cheaper roads could be built, the money for their construction might be obtained. They immediately, therefore, jumped to the conclusion that, because a gage of 36 in. is only about three-fifths of 56 in., a road of that gage could be built for a correspondingly lower price, and straightaway positive statements were made to that effect, which were honestly accepted by a large number of men. It was assumed that, because the gage was to be narrowed, all costs would be cut down in a corresponding degree. It was argued that because of the narrow gage, the cars would be made lighter than those which it had been found advisable to use on the broad gage, forgetful of the fact that equipment of the same, or even lesser, weight could be and had been built and used on the standard-gage lines, and had been found unsatisfactory.
>
> The whole case rested, apparently, so far as the United States was concerned, on the inability to raise money for ordinary railroad construction, and the narrow gage seemed to promise greater dividends on a given investment. It was characteristic of the whole discussion that the advocates of the narrow gage insisted throughout that their construction was the cheaper, and could not or would not see their opponents' side of the case, which was, that the narrow-gage could not be built materially, if any, cheaper if the same facilities and capacity for the transportation of freight and passengers were to be afforded. They failed to see or acknowledge that a light locomotive and car could be built for a broad-gage line.
>
> The physical disadvantages of the narrow gage, such as cramped storage and seating capacity, the greater instability of the rolling stock, and, above all, the chief drawback of the impossibility of interchanging cars with the standard lines, with the consequent extra cost and delays in transportation, were pointed out again and again, but in spite of all this the narrow gage construction went on for several years, and, until the money market eased, made a great headway.
>
> The result of the 40 years of practical experience that has elapsed since the battle of the gages was precipitated in the early '70's, has been to quite discredit the narrow-gage system. It has been proven beyond all peradventure that the narrow-gage railway cannot be operated so as to keep its ton-mile costs down to the figure obtained on the standard-gage roads.

It would appear from the above account that promoters and financiers and not engineers were chiefly responsible for the introduction of the narrow-gage system in the United States. It should be said, however, the narrow-gage system is much older than might appear from the above quotation. A booklet has just been printed in Brisbane, Australia, celebrating the completion of the first half century of railway construction in the Colony of Queensland and giving the history of the beginnings of railway construction there.

The Queensland Government introduced a bill in 1863 providing for the construction of railways by the Government on a gage of 3 ft. 6 in., recommended by Abram Fitzgibbon, C. E. We quote from the booklet as follows:

> Mr. Macalister, the Premier, submitted correspondence from Robert Tooth & Co., in which they, on the recommendation of Abram Fitzgibbon, C. E., made a proposal to build a line of light railway of 3-ft. 6-in. gage at a cost of $20,000 per mile, exclusive of rolling-stock and land.
>
> It was stated for the information of the House, that Mr. Fitzgibbon had been apprenticed to a leading civil engineer in Ireland, and had been employed by various eminent firms, including Fox, Henderson & Co., who had sent him to the United States to estimate the cost of a railway, and later to Ceylon to supply an estimate of works of considerable engineering difficulty.

This information was necessary in view of the fact that those members of Parliament and that portion of the general public which regarded with suspicion the proposal to use a 3-ft. 6-in. gage, included within the bounds of their suspicion the engineer who made the proposal.

Before the final acceptance of the Railway Bill, a committee of the Legislative Council summoned a number of engineers, surveyors, and contractors to the bar of the House. Among the chief witnesses was Mr. Fitzgibbon, who, in answer to inquiries, said the 3-ft. 6-in. gage would be all the colony required if satisfied with a speed of 20 miles an hour. He would rather travel on that gage at 20 miles an hour than on a 4-ft. 8½-in. gage at 40 miles an hour. It would, he believed, be throwing money away to build the wider gage. It would be like employing an elephant to do a horse's work.

As argument in support of his opinion, Mr. Fitzgibbon said the engines used on a 3-ft. 6-in. gage would be of light construction, and there would be less wear and tear on the rails. The engines which he recommended for the purpose would be very like the old engines used in England in 1839 and 1840, but would have the advantages of modern improvements.

Under further cross-examination Mr. Fitzgibbon said that where the width of the gage had been increased in England so that a speed of from 50 to 60 miles an hour might be attained, the wear and tear on the rails was enormous, and they had to be replaced in a very short time. To run trains on a 4-ft. 8-in. gage at the speed usual in England it would be unsafe to have curves of less than 10 chains radius. The speed at which he proposed to run on smaller curves on the narrower gage would be as safe as on the 4-ft. 8½-in. gage in England. If 3 ft. 6 in. were accepted as the standard gage, it would answer all the purposes of Queensland for a hundred years. He did not contemplate going at a greater speed than 10 miles an hour on the curves of 5 chains radius, which curves only occurred on an incline. On other parts of the line the curves would have a 10-chain radius, and faster speed could be maintained.

Mr. Plews, C. E., expressed practically the same opinions. He said there would be no danger at all on the narrow gage as long as the way was kept in good order—the center of gravity of the carriages with load kept low—and the speed on the straight line be 20 miles an hour in a curve of 10-chain radius.

Two other prominent witnesses examined at the Bar—Messrs. Coote, C. E., and Gregory, Surveyor-General—were totally opposed to Mr. Fitzgibbon's scheme.

The experience of a half century has demonstrated that the narrow-gage system can be developed to carry much heavier traffic and much higher speeds than its original advocates claimed; but it has likewise demonstrated that a standard-gage line has much higher limits of traffic capacity and speed and is just as adaptable as a cheap railway to handle light traffic as the standard-gage.

It appears clear that the weight of engineering opinion a half century ago was against the narrow-gage system, although as often happens, there was more or less disagreement inside the profession itself. It is probable, too, that the attitude of the engineering profession itself was partly responsible for the birth and growth of the narrow-gage system. English engineers in the '40's and '50's were firm in their adherence to low grades and very easy curves and resulting high cost as a necessary feature of standard railway construction. They had, in fact, little conception of the possibilities of the standard-gage system as a cheap railway by introducing heavy grades and sharp curvatures. The promoters of the narrow-gage system found their opportunity because of the ultra-conservatism of the older generation of engineers.

Letters to the Editor

European and American Ways of Operating Sewage-Treatment Works

Sir—During a recent visit to Europe the writer inspected the sewage-disposal works of a number of important cities and was impressed in each case with the evidence of coöperation between the city administration and those directly responsible for the operation of the plants in seeing that they were properly manned with the requisite amount of intelligent help and provided with scientific and professional skill to the end that the best and highest results would be secured from the plant. This attitude is, in the writer's opinion, largely responsible for the fact that Europe continues to lead in practically all advancement in sewage disposal.

Contrast the attitude in European cities with the attitude of the officials in one large American city which a year ago installed a modern sewage-disposal plant, as evidenced by the following letter which I find upon my return from Europe:

DEAR MR. POTTER—I am writing you today to let you know that I have resigned from the job of taking care of the sewage-disposal plant. I was sick in bed for several days with a very bad case of the measles and when I got back on my feet I found things at the plant in a very bad condition—one of the engines froze and burst, and one set of the distributors was out of commission on account of the cable being torn to pieces; and still the Council refuses to let me have a man for the night shift that is capable of taking care of things when I cannot be there, and I told a few of these would-be politicians what I thought of them. The Mayor is giving me a good letter of recommendation, which shows that he knows I performed my duty.

I notice this morning that the plant is closed down. I do not know what the trouble is, but I think it will be found that way quite a good deal now if the city is not careful.

This man and an old man used as night watchman were the only employees on two plants five miles apart. Repeated and urgent recommendations to employ a chemist to secure definite information as to the performance of the plants and to regulate them accordingly, and also to provide intelligent supervision of the plants day and night, have failed to secure response. What advance in sewage purification can be made under such conditions? What incentive can there be for an engineer to introduce new methods and improved devices? While the case referred to may be an aggravated one, it certainly is not the only mismanaged sewage-disposal plant in America.

ALEXANDER POTTER.

50 Church St., New York City, Mar. 27, 1914.

[What Mr. Potter states regarding the neglectful manner in which many American cities operate their sewage-treatment is only too true, as other engineers can testify and have repeatedly testified. The responsibility lies with city authorities who are untrue to their trust—or perhaps we should say with voters who put untrustworthy and ignorant men in our city councils.—ED.]

The Am. Soc. C. E. Constitution

Sir—Recent numbers of the NEWS have been rife with articles regarding the Am. Soc. C. E., and amendments to its constitution.

What the future of the Am. Soc. C. E. may be is, of course, impossible to predict. However, its phenomenal development suggests that its constitution is founded on bedrock, and future effort should be directed toward the enlargement of the superstructure and its adaptation to the growing needs of engineers. The writer is at a loss to understand how any post-criticism in a journal can at all assist; it is a proceeding at variance with sound method.

A recent contributor quoted "Lowell." No doubt he is familiar with the following, by the same author:

> Nature fits all her children with something to do,
> He who would write and can't write, can surely review;
> Can set up a small booth as critic and sell us his
> Petty conceit and his pettier jealousies.

Also the following:

> A terrible thing to be pestered with poets.

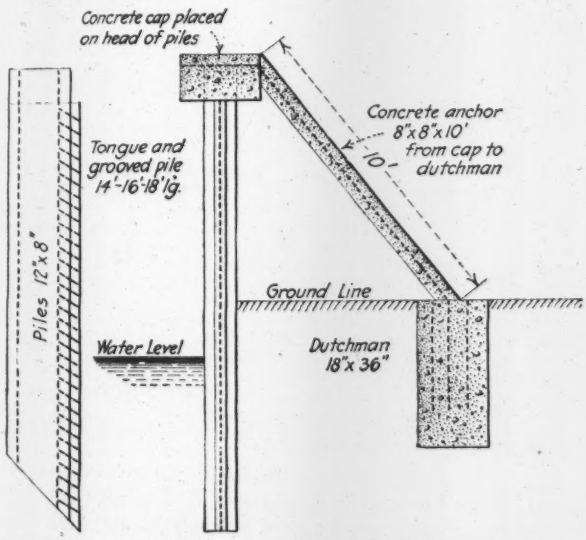
Both the above are from "A Fable for Critics."

J. O. ECKERSLEY,
M. Am. Soc. C. E.

New York, Mar. 30, 1914.

A Reinforced-Concrete Sheet-Pile Retaining Wall

Sir—I note with interest in your issue of Feb. 5, 1914, p. 292, a description of a sheet-pile sea wall originated by T. L. Trawick, of New Orleans, this wall being built by Burton Victor who holds the patent for its design. It might interest you to note that in 1908 the writer designed and built a concrete sheet-pile retaining wall in front of two dams of our water supply.



DETAILS OF A CONCRETE SHEET-PILE RETAINING WALL BUILT IN NORFOLK IN 1908 BY T. B. DORNIN

The total length of wall built was 2000 ft. and the cost was as follows:

Equipment	$3500
Construction of wall	14,500
Total cost	$18,000

The above equipment consisted of a floating piledriver, tow boat and two barges, all small tools, etc., being charged to construction.

T. B. DORNIN,
Engineer in Charge, Department of Water.
Norfolk, Va., Mar. 26, 1914.

Shore Protection at Seabright, N. J.

Sir—The owners of the beach front in this vicinity are putting in wooden bulkheads to repair in part the damage done by the severe storms of last December and January. Of course, this is only a temporary protection as the life of a wooden bulkhead is about six to ten years, under favorable conditions.

The ocean currents in this vicinity seem to run from south to north, cutting away the beach front and carrying the sand to the point of Sandy Hook. It seems to me that some means should be provided to break these currents and keep the sand in its normal place.

As this is a large undertaking, it is too much for the individual owners in this section to contemplate. We have, therefore, asked for Federal aid to devise a way and put up a breakwater or bulkhead or groins which will preserve this peninsula. Unless the Government does this, eventually there will be inlets along the coast into the Shrewsbury River, thus stopping navigation there.

If this occurs, Fort Hancock, on Sandy Hook, will have no land communication, which is essential, and the sand washing to the north beyond Sandy Hook point will be a menace to the ship channel. Therefore, we think the Federal government should devise ways and means for such protection and that they will be the greatest benefactors therefrom.

GEO. W. ELLIOTT, Mayor.

Seabright, N. J., Mar. 26, 1914.

[The foreshore protection at Asbury Park, N. J., by means of a system of timber groins, is described in another part of this issue.—ED.]

NOTES AND QUERIES

A correspondent inquires what are the heaviest rolled structural shapes. We believe the following Bethlehem sections are the heaviest rolled in this country: I-beam, 30-in. depth, 15-in. width, ⅞-in. web, 1⅛-in. flange, 200 lb. per ft. Bethlehem H-beam, 16⅞-in. depth, 14.9-in. width, 1.4-in. web, 2¼-in. flanges, 287.5 lb. per ft.

In the note headed "Litigation Over Meter and Fire Protection Charges" at Wilkinsburg, Penn., on p. 705 of our issue of Mar. 26, it was stated that the Pennsylvania Water Co., of Wilkinsburg, "had won its contention for a fire protection charge of $275 per mile of distribution main plus a 'nominal charge' of $15 for fire hydrants." We are informed by W. C. Hawley, Chief Engineer of the Pennsylvania Water Co., that in accordance with its schedule of rates for water supplied to various municipalities the rate for public fire protection is $325 per mile of pipe per year, and $15 per year for hydrants in the case of municipalities without contracts, or where the contract is for a term of one year. For longer term contracts the rates are less, and for contracts running ten years the rate is $275 per year per mile of pipe plus $6 per year per fire hydrant. Mr. Hawley adds:

> Six dollars per year barely covers interest, maintenance, depreciation and taxes on an average cost of $50 per hydrant set, including connection with main and the hydrant lateral.

Bridge Failure at Attica, Indiana

By Albert Smith*

The failure of the Wabash R.R. bridge over the Wabash River, at Attica, Ind., noted in Engineering News of last week, had some specially interesting features.

The Bridge

This bridge, built in 1892, consisted of six through Pratt truss spans of 110 ft., 154 ft., 156 ft., 156 ft., 152 ft., and 131 ft., and twelve 78-ft. deck plate-girder spans. The six truss spans were on the east end of the bridge. The trusses had 22-ft. and 25-ft. panels and were 26 ft. in height. Data in regard to their designed loads are not available, yet a study of the end-post section given below shows that the bridge was not seriously overloaded, in spite of the fact that the Wabash R.R. has been running 210-ton freight locomotives over it.

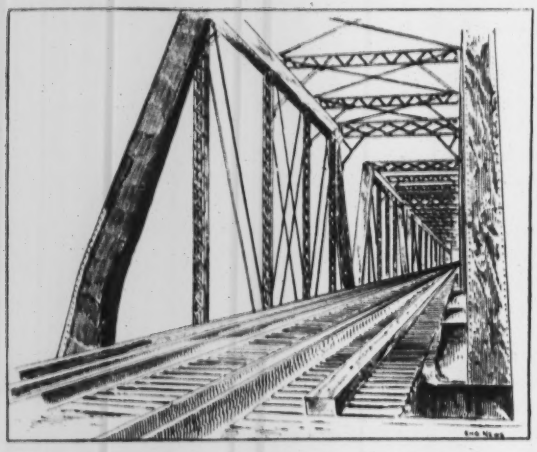


Fig. 1. Damaged End-Post of Attica Bridge, Before Passenger Train Came on Bridge
(Sketched from a photograph.)

The Accident

About 12 noon, on Sunday, Apr. 5, 1914, a westbound freight train pulled out of Attica over the bridge. On the curve just at the entrance to the bridge, a refrigerator car was derailed; by the time it had reached the bridge portal the car was so far out of line as to hit the south end-post of the bridge, bending it as shown in Fig. 1. The shock of the blow threw the refrigerator car back on the track, and before the train was stopped the derailed car was dragged into the third span; the rear truck of the refrigerator car was knocked off and fell through the south truss to the bank beneath. The car was disconnected front and rear, and the engine took the front portion of the train to Williamsport, while the rear portion was pulled eastward off the bridge. The freight engine, returning, pushed the derailed car to the east end of the bridge, where it was overturned down the bank to clear the way for the Continental Limited, which was due in Attica at 1:53 p.m.

*Professor of Structural Engineering, Purdue University, Lafayette, Ind.

The freight engine which thus passed [illegible] the span with the injured end-post weighed 210 [illegible] Track Supervisor Whitehead, standing below [illegible] bridge, watched the passage of the freight engine [illegible] reported no apparent yielding of the structure.

The condition of the end-post after being [illegible] by the refrigerator car is shown by Fig. 1. Fig. [illegible] shows the section of this post, sizes of the material, [illegible] the area. The condition of this member is such that [illegible] seems remarkable that it could have carried the we[illegible]t of the freight engine or even the dead-load of the br[illegible]ge. Scaling the photograph shows a bend of 7½ in. fro[illegible] the true line. The maximum stress in the end-post from this engine is 236,000 lb. The bending stress induced by the eccentricity is 1,780,000 in.-lb. If the cover plate had not been split, as shown in the photograph, the bending moment would produce a fiber stress of 13,300 lb. per sq. in. in the outer fibers, supposing the forces centrally applied at top and bottom. The direct stress was 8300 lb. per sq.in., giving a total of 21,600 lb. per sq.in. The long split in the cover-plate must have caused the end-post to act as two separate members over a length of 6 ft.

Marvelous as it seems, the freight engine got safely across. This was regarded as a sufficiently reassuring test, and the Continental Limited, waiting at the west end of the bridge, proceeded very slowly to cross the injured span. This train consisted of engine, tender, mail car, combination coach, and day coach followed by sleepers.

As the pilot truck of the passenger locomotive was over the east abutment the injured south truss yielded, carrying with it the north truss and dropping engine and tender to the sloping bank below, and southward of the center line of the bridge. The mail coach pitched forward into the corner of the tender and its rear end was thereby thrown to the north, carrying with it the front end of the combination coach following. The combination coach was thrown against the north end-post of the second span, causing the north truss of the second span to fall, carrying with it the south truss, and dropping the combination coach into the river to the north of the center line of the bridge. Four panels of the second span, containing a day coach, remained propped up on the second pier.

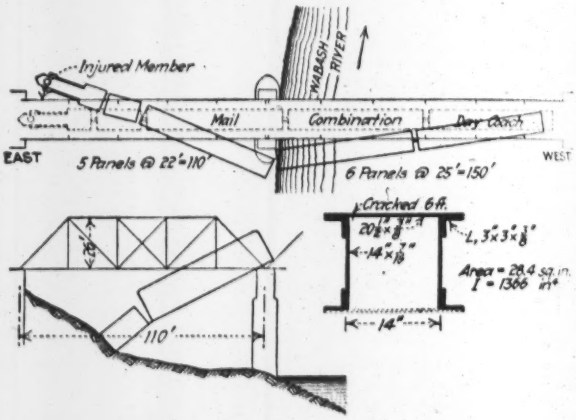


Fig. 2.

Fig. 3.

Fig. 2. Sketch of Positions of Engine and Cars of Passenger Train After Attica Bridge Fell. Fig. 3. Section of End-Post Which Failed.

Three lives were lost and six mail clerks and twenty-nine passengers were injured, six of them seriously. It is thought that the fact that the coaches were of steel had much to do with the small loss of life, although this was partly due to the fact that none of the coaches turned over.

The location of the wrecked span and the fallen cars is shown in Fig. 2. The above description of the manner of failure of the second span is sufficiently attested by the fact that the tender is badly crumpled at the north rear corner and that the second truss fell to the north. The first pier was a fixed end for both spans and where the shoes pulled away large fragments were spalled away from the top of the pier.

The condition of a vertical post of the second span is worthy of comment. This post was made of 10-in. channels, spaced 10 in. back to back. The channels are broken just above the floorbeam connection. The cause of this break could only be bending, from the warping of the truss. The area of these channels is 4.46 sq.in. gross, 3.59 sq.in. net, and the ultimate strength of the post in resisting bending should be $3.59 \times 55{,}000 \times 8.73 = 1{,}730{,}000$ in.-lb. The point of contraflexure of this post was probably not more than 2 ft. below the upper pin. To develop a moment sufficient to break the post at the top of the floorbeam, there must have been a cross-plane shear in this post equal to $^{1{,}730{,}000}/_{228}$ in. = 7600 lb. The lacing bars, $2\frac{1}{4} \times \frac{5}{16}$-in. panels, 7½ in., which transmitted this shear must have endured a stress of 5000 lb. It must be remembered that at the time this cross-plane shear occurred the post was carrying no direct stress; nevertheless, the performance of these lacing bars seems remarkable.

Automatic Train-Stop or Train-Control Systems

The question of the advisability and practicability of using automatic train-stops has been under consideration by the American Railway Association for some time, and at the meeting in November, 1913, its Joint Committee on Automatic Train Stops submitted a brief report with a revision of the requisites of installation for apparatus of this kind. An abstract of the report is as follows:

Great care must be exercised in working out a system of automatic train control in order to avoid the introduction of new elements of danger in operation which may offset those they are intended to overcome.

The successful stoppage or reduction in the speed of a train composed of many freight cars or of heavy passenger equipment requires the exercise of skill and judgment on the part of the engineman in handling the air brakes. If this is improperly done serious damage to the train and possibly to the track and to trains on parallel tracks may follow. The sudden application of the brakes by an automatic device without the exercise of intelligence in its performance is therefore necessarily hazardous.

No automatic train control device, so far as known, can be universally applied without adding elements of danger in train operation. The expediency of its installation at any point must be determined by the conditions surrounding the proposed location.

Requisites of Installation for a Train-Control System

The committee explained that proposed requisites of installation are designed to apply only where the traffic conditions justify the use of an automatic block signal or interlocking system, and the operation of such signal or interlocking system is so nearly perfect as to indicate that the efforts of railway officials and public authorities should be directed toward the enforcement of obedience to signals rather than in the installation of additional devices.

There was some discussion as to whether or not there is any device yet developed which will meet all conditions of railway service; that is, whether any device is practicable for safe operation with regular traffic on the open line, as well as in subways or tunnel lines, and for both heavy freight and fast passenger trains. The diverse views expressed in this part of the discussion led to the report being referred back to the committee. Another point was in regard to whether the engineman should be able to release the brakes before the train comes to an absolute stop, and as to this the committee itself is of divided opinion.

There is also the question of enabling the engineman to put the apparatus out of operation in case it should fail in such a way as to leave the brakes applied. This could be provided for by placing the cutout device in a glass-front box, the breakage of which would call for explanation by the engineman. In regard to the use of a detonating device as an adjunct to the train-control system, it was suggested that enginemen might rely too much upon the audible signal and relax their vigilance in watching for the visible signals.

The requisites as submitted by the committee (revised from the original form submitted by it in May, 1913) are as follows, and they stand as the latest standards which should be observed by those working on the problem of automatic train stops*.

1. The apparatus so constructed that the failure of any essential part will cause the application of the brakes.
2. The apparatus so constructed that proper operative relation between those parts along the roadway and those on the train will be assured under all conditions of speed, weather, wear, oscillation and shock.
3. The apparatus so constructed that to insure compliance with speed restrictions a train may pass a trip in the tripping condition without brakes being applied, provided the train speed is less than a predetermined rate and the fixed signal indicates proceed.
4. The train apparatus so constructed as to prevent the release of the brakes after automatic application has been made until the train has been brought to a stop or the speed of the train has been reduced to a predetermined rate.
5. The train apparatus so constructed that when operated it will make an application of the brakes sufficient to stop or control the train within a predetermined distance.
6. The apparatus so constructed as not to interfere with the application of the brakes by the engineman's brake valve or the efficiency of the air-brake system.
7. The apparatus so constructed as to be operative when the engine is running forward or backward.
8. The apparatus so constructed that when two or more engines are coupled together or a pusher is being used the apparatus can be made effective on the engine only from which the brakes are controlled.
9. The apparatus so constructed as to be operative on trains moving only with the current of traffic.
10. The apparatus so constructed as to conform to the American Railway Association standard of clearances of rolling equipment and structures.
11. The apparatus so constructed as not to constitute a source of danger to employees or passengers, either in its installation or operation.
12. The apparatus so constructed as not to interfere with the means used for operating fixed signals.

ADJUNCTS—The following may be used: A Cab Signal; to be so constructed that the failure of any part directly controlling the signal will cause it to give the "stop" indication. B. Recording Device; so constructed as to make a record of the number of times the automatic stop has operated the brakes. C. Speed Indicator. D. Detonation apparatus.

*It is of interest to compare these requirements with those given by the U. S. Block Signal and Train Control Board, in "Engineering News," Jan. 19, 1911.

Venturi Meters in the Catskill Aqueduct

By Fred F. Moore*

SYNOPSIS—Interesting problems in design and methods of construction of Venturi meters are described. The largest of these meters are of reinforced concrete, 17½ ft. in maximum diameter, over 400 ft. long and with capacities of 700,000,000 and 800,000,000 gal. per day.

About the year 1887, Clemens Herschel, who was then hydraulic engineer of the Holyoke Water Power Co., at Holyoke, Mass., resolved to make experiments with the object of developing a ready means of measuring the quantity of water flowing in pipes of the larger sizes. He first considered that determinations of quantities might be made from observations of the pressures on both sides of an orifice of proper size in a diaphragm introduced into a pipe. Further consideration of the problem resulted in the modification of filling in the spaces on each side of the orifice in such a way that changes in velocity would be gradual instead of sudden, and the losses of head thereby much reduced.

Mr. Herschel's experiments soon developed essentially the form of the meter tube as we have it today, consisting of a throat with piezometer pressure chamber, a conical short flare upstream to pipe size with another piezometer pressure chamber, and a long conical flare downstream to pipe size. In such a meter tube, if properly designed for the governing conditions, the quantity flowing bears an unvarying relation to the difference between the pressures at the two chambers.

In recognition of Prof. Giovanni Battista Venturi, an Italian savant, man of letters and diplomatist, whose reported studies of the flow in diverging tubes about a century before had helped to point the way, Mr. Herschel named his apparatus the Venturi meter, and thereby has awakened memories of the contributions to hydraulic science of an engineer whose name, but for this generous act, might have nigh remained buried in oblivion.

Mr. Herschel's patents were acquired by the Builders Iron Foundry, of Providence, R. I., which company developed ingenious registering, indicating and recording apparatus for the meter. Since it became a commercial proposition, about 1890, the Venturi meter has been used to measure the flow of water under a wide range of conditions, varying from a special form for the lateral canals of irrigation systems under very low pressures in the southwestern parts of the United States to meters under about 450 lb. pressure per sq.in. in some power-supply lines. The meter has been adapted to measure the flow of sewage, compressed air, steam and gas. In size, the meters range from the smallest, ½ in. in diameter, to the largest in the world with tubes 17½ ft. in diameter, a part of the Catskill Aqueduct.

Because of the reliability and continuity of its record, wide range of adaptibility, ease of operation and low cost of maintenance, the Venturi meter is of particular value when used in measuring the flows in aqueducts and pipes of water-supply and water-power works. Used in this way, its records have added to our store of general knowledge, and its indications have resulted in the saving of much money from the prompt detection of leaks, wastes and the falling off of turbine and pump efficiencies.

Venturi meters were adopted for measuring the flow in the aqueducts of New York City's Catskill Water System, because no other method nearly as good was available. In order to understand the functions, and relations one to the other, of these meters, it will be necessary to give brief attention to the principal features of the Catskill Water System. The water will be impounded in reservoirs in the Catskill Mountain watersheds; the Ashokan Reservoir, now approaching completion, is about 90 miles north of New York City. From the impounding reservoir, the water will flow by gravity through the Catskill Aqueduct to the Kensico storage reservoir about 15 miles north of the city line, from whence the flow will be continued by gravity in the aqueduct to the Hill View equalizing reservoir, just north of the city line. From Hill View Reservoir, a pressure tunnel deep in the rock extends the length of Manhattan Island and under the East River into Brooklyn. Frequent connections will be made along the line of the tunnel with the pipe distribution system, and pipe extensions from the end of the

*Designing Engineer, Board of Water Supply, Municipal Building, New York City.

VENTURI METERS IN CATSKILL WATER SYSTEM, NEW YORK CITY

Location	Tube drain ft. in.	Dimensions throat diameter ft. in.	Approximate length cut, ft.	Maximum head on center line of meter, ft.	Maximum quantity to be measured million gal. per day	Remarks
Below Ashokan Reservoir	17 6	7 9	410	25	700	Reinforced-concrete tubes; bronze throat and upstream piezometer castings.
Above Kensico Reservoir	17 6	7 9	410	25	700	
Below Kensico Reservoir	17 0	7 9	430	28	800	
Kensico Dam	10 0	5 0	50	135*	600	Concrete tube; bronze upstream and bronze-lined throat piezometer castings.
Kensico Dam	3 0	1 3	20	135*	25	Cast-iron tube; bronze-lined throat.
Pressure tunnel south of Hill View Reservoir	15 0	8 8	140	356**		Piezometer castings of bronze. Pressure chambers and piezometer connections double on account of difficulty of access.
Pressure tunnel connection to Jerome Park Reservoir	8 0	4 6	120	192**		Piezometer castings of bronze. Designed to measure flow in either direction.
66-in. steel pipe line, 3rd Ave. and Schermerhorn St., Brooklyn	5 6	2 4	50	265**		Cast-iron throat and steel cones; bronze bushings in holes to pressure chambers.
66-in. steel pipe line, Fort Green Park, Brooklyn	4 0		50			
36-in. cast-iron pipe line, 79th St. and Shore Road, Brooklyn	3 0		25	290**		
36-in. cast-iron pipe line, Ariette St. and Stuyvesant Place, Staten Island	3 0		25	285**		

* Below high water in Kensico Reservoir. ** Below high water in Hill View Reservoir.

In addition to these meters now provided for, it is expected that there will be a meter on each connection from the shafts of the City Tunnel to the distribution system; this may require ultimately about 60 meters.

tunnel in Brooklyn will be carried through the Borough of Queens and another across the Narrows to the Silver Lake distributing reservoir, on Staten Island.

North of Hill View Reservoir, there are three meters forming parts of the aqueduct constructed in open cut. South of the reservoir other meters will be parts of the construction in tunnel and in riveted-steel and cast-iron pipe. The locations of the meters and their principal properties are indicated in the accompanying table.

Functions of Meters and General Considerations in Design

As will be readily appreciated, the purpose of the meters in the pressure tunnel and in the pipe extensions south of Hill View Reservoir is that of measuring the quantities of water supplied to different parts of the greater city. The three meters north of Hill View Reservoir have a somewhat wider function. For its usefulness in regulating the flows to some predetermined quantity, a meter is placed in the aqueduct just below the outlets of both reservoirs. Another meter just above the aqueduct inlet to Kensico Reservoir furnishes a positive measurement, in connection with the meter below, of gain or loss in storage through runoff from the watershed of the reservoir, evaporation from water surface, leakage of reservoir structures, and other local causes. Besides these functions, the meters as located will furnish useful information as to net gain or loss of aqueduct water through leakage and infiltration, one or the other of which will take place in some measure for the greater part of the length of the aqueduct.

As all of the meters are in the direct line of the aqueduct, pipe or conduit and there are no bypasses around them, they are designed to have the full capacity of the structures of which they form a link. They will operate under full capacity with positive throat pressures at the indicating apparatus, and with losses of head which will never be more than one foot for the whole length of the larger meters. The saving of head was important, because extravagance in this particular would result in larger size and increased cost per foot for the whole length of this long aqueduct.

Design of Meters in Open-Cut Aqueduct

It was necessary that the meters in the open-cut aqueduct be so constructed that the tubes would be full of

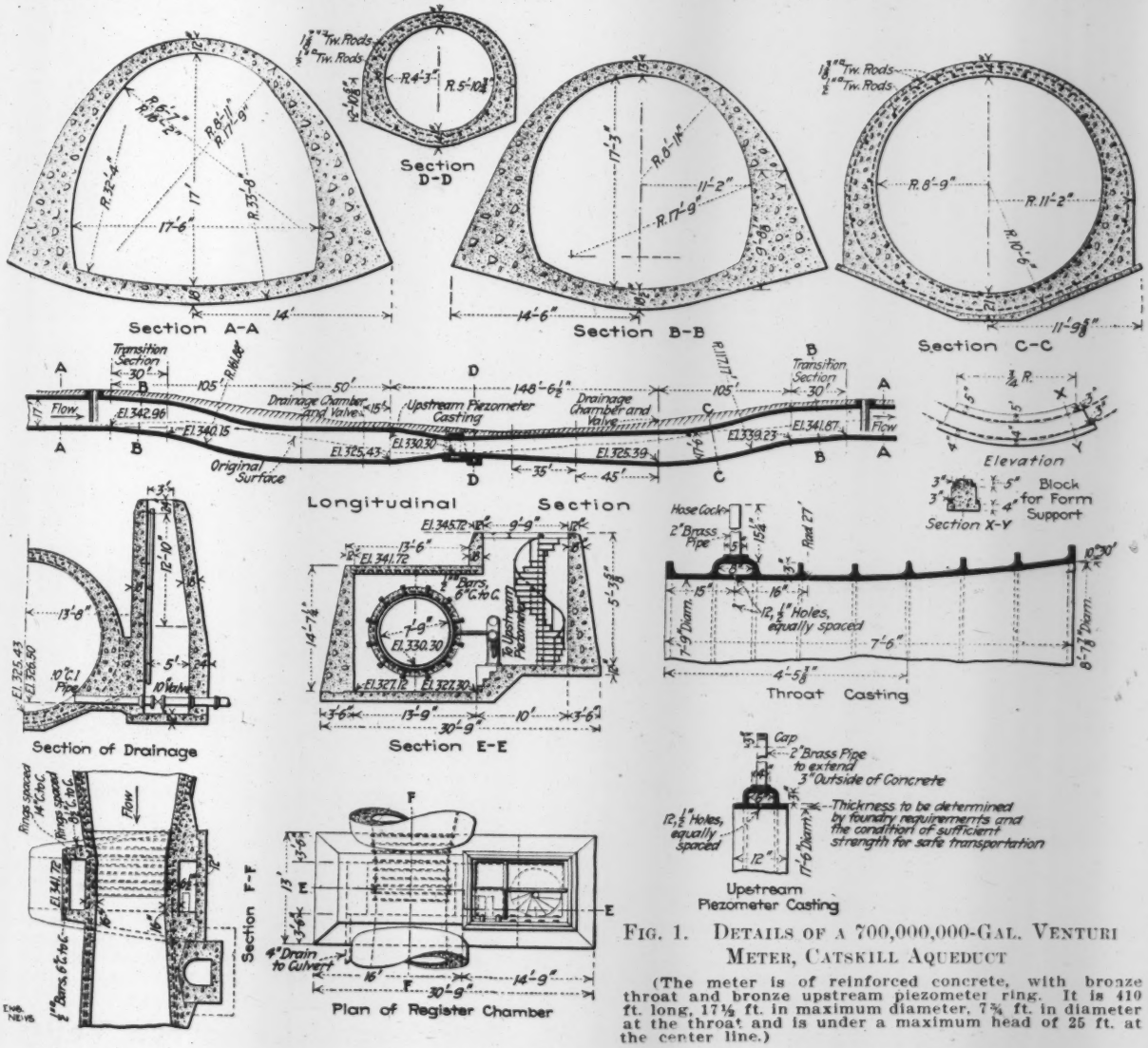


Fig. 1. Details of a 700,000,000-Gal. Venturi Meter, Catskill Aqueduct

(The meter is of reinforced concrete, with bronze throat and bronze upstream piezometer ring. It is 410 ft. long, 17½ ft. in maximum diameter, 7⅝ ft. in diameter at the throat and is under a maximum head of 25 ft. at the center line.)

FIG. 2. BRONZE THROAT CASTING SET AND BRACED IN POSITION

FIG. 3. BUILDING CONCRETE FORM FOR SECTION OF DOWNSTREAM TUBE ADJOINING BRONZE THROAT CASTING

FIG. 4. BRONZE THROAT CASTING INCLOSED IN CONCRETE, CONCRETE REGISTER CHAMBER, AND CONCRETE CRADLE FOR METER TUBE.

(Although the major portion of the Kensico meter and approaches was built on rock foundation it was deemed advisable to build a cradle throughout, on account of the large amount of work that would have to be done over the bottom of the cut in building support blocks, placing forms, assembling steel, etc. Even with this cradle it was found extremely difficult to get the space under the forms properly clean for placing the concrete.)

FIG. 5. PLACING STEEL REINFORCEMENT FOR UPSTREAM METER TUBE.

(For both this and the other truncated cone a different length of both inner and outer rod was required for each position. At the left there may be seen a complete ring of reinforced concrete around the bronze throat casting.)

The meters are essentially of the same design, and the construction views are not of one particular meter throughout, but are selected to be, in general, typical of all.

The meters are about 400 ft. long and are an integral portion of the aqueduct, changed by transition sections from standard aqueduct to circular form and constricted to a bronze throat set in concrete, with bronze piezmeter rings at the upstream and downstream ends and a concrete register chamber at the side. The meters are built at points where the aqueduct crosses natural depressions, as shown in the large location view on the opposite page.

The group of views shows the setting, bracing and encasing of the bronze throat, the placing of some of the reinforcing steel and various other stages in the construction of the meters. For details of design see Fig. 1 on a preceding page.

Construction Views of 17 1-2 ft. Reinforced-Concrete Venturi

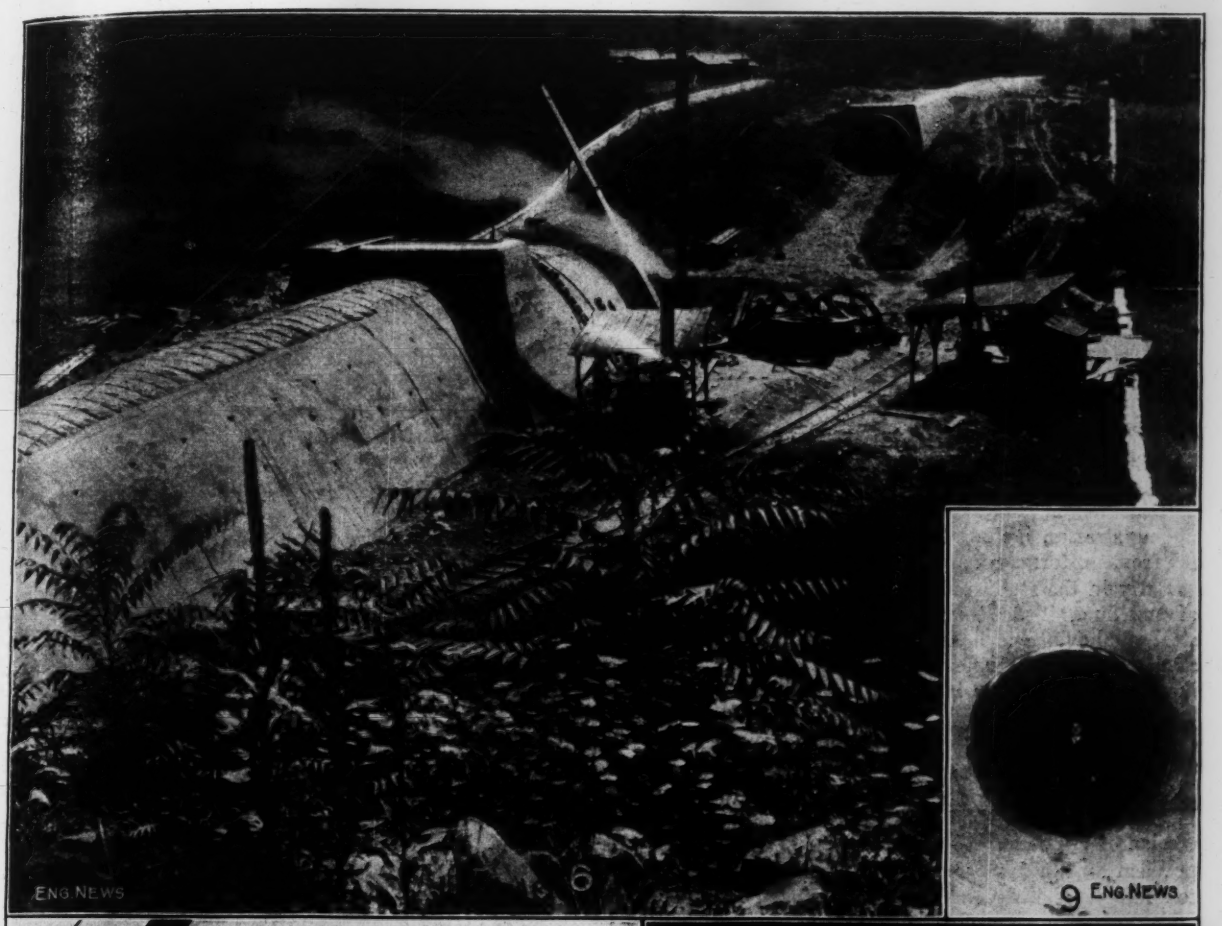


FIG. 6. GENERAL VIEW OF LOCATION OF ONE OF THE METERS BEFORE CONSTRUCTION

(The chambers shown at either end are for the admission of inspection boats. A portion of the exterior of the regular section of the aqueduct may be seen at the left and a cross-sectional view in the extreme right distance.)

FIG. 7. TRANSITION SECTION FROM STANDARD AQUEDUCT SECTION TO CIRCULAR SECTION OF METER TUBE, AT UPSTREAM END

FIG. 8. LOOKING UPSTREAM FROM A POINT JUST DOWNSTREAM FROM THE BRONZE THROAT CASTING

(In the foreground is the throat casting; in the middle distance, the bronze upstream piezometer casting; in the background, the completed reinforced-concrete meter tube, of maximum section.)

FIG. 9. INTERIOR OF REINFORCED-CONCRETE METER TUBE, LOOKING DOWNSTREAM TOWARD BRONZE THROAT CASTING

Meter in Open Cut, Catskill Aqueduct, New York Water Supply

water for the smallest flows. Accordingly, locations were sought, near the desirable geographical positions for the meters, where the profile of the surface favored minimum construction cost for these depressed portions of the aqueduct. A study of possible types of construction for the meters, including some experiments with reinforced-concrete aqueduct sections, led to the decision to construct the meters of reinforced concrete and introduce bronze linings at the throat and upstream piezometer. Bronze was selected for these important parts, because it seemed to promise a long life without change in area of water section from erosion, or roughness of surface from corrosion, and the probability of less fouling of surface from growths of organisms than would be the case with other available materials. There was presented for design, then, an aqueduct section of uniformly varying diameter, loaded internally and externally. The internal load results from a head of water not more than two or three times the diameter, giving a pressure at the bottom greater than at the top. The external loads producing stresses, including the weight of the masonry, are far from uniform.

Early in the studies looking to the design of this type of aqueduct, it was recognized that the stresses in the steel would have to be low enough so that concrete and steel would act together in tension without cracking of the masonry, in order to obtain water-tightness and protection for the steel. Besides the loss of water and other evils incidental to leakage which obtain in general for all types of aqueduct, we have the peculiar objection in the type under discussion that leakage past the reinforcing metal would give rise to corrosion and subsequent erosion of the steel.

When the studies were undertaken, the only reinforced-concrete pipes which had been constructed for operation under pressure were some put down by the United States Reclamation Service. These pipes were reasonably tight; but a study of the conditions indicated that a considerable turbidity of the water was probably an important factor in the leakage results obtained, as it appeared that cracks in the concrete were closed by entrained fine silt extracted from the water. As the clear, potable water which is to flow in the Catskill Aqueduct would not be expected to furnish silting materials, tests of aqueduct sections under conditions as nearly as possible like those of the actual service appeared justified as a precedent to the design of these important structures. There are reinforced-concrete sections of the aqueduct other than the Venturi meters. These sections, including the meters, aggregate about 16,000 ft. in length, and will be operated under heads exceeding in no case 50 ft. on the center of the pipe. These reinforced-concrete sections are for the most part single-unit links in the aqueduct chain and should be as tight, safe and lasting as the standard, plain concrete section, which is liberally designed for long, continuous service.

A test section of reinforced-concrete pipe, 11 ft. in diameter and 210 ft. long, was constructed on the aqueduct line in one of the lesser depressions to become a part of the permanent structure if found upon test reasonably satisfactory for the purpose. This test section was 8 in. thick, reinforced with rings of twisted, square steel bars; in part with single rings of 1⅜-in. bars, spaced 4⅝ in., and in part with double rings of 1-in. bars spaced 4⅛ in. Concrete was mixed in the proportion of 1 volume of cement to 5½ volumes of aggregate, broken stone with sand and with screenings, and gravel with sand being used. The pipe was tested when 6½ to 8 months old.

The tests of the experimental pipe showed it quite satisfactory up to pressures of about 40 lb. per sq.in., but at higher pressures it leaked through joints which formed in the concrete. For pressures up to 40 lb. per sq.in., the quantities of water which passed through the walls of the pipes were consistent with the laws of percolation through concrete. The leakage increased rapidly with increases of pressure above 40 lb. per sq.in., and at about 54 lb., numerous longitudinal cracks formed, some large enough to be plainly visible on the outside of the pipe, but mostly observed only on the inside wall when drying. The pressure cracks differed in behavior from the porosity of the concrete at the lower pressures, in that they did not tend to silt up. On the contrary, the pressure cracks seemed to enlarge with repeated applications of the pressure.

These tests supplied knowledge of quantitative value for determining the control of stresses in the materials necessary for a reasonable measure of water-tightness. An analysis of the results, supported to some extent by experience with similar pipes constructed by the Reclamation Service, led to the adoption of 200 lb. per sq.in. for maximum working tensile strength in concrete, concrete and steel acting together, and 6000 lb. per sq.in. for maximum working tensile stress in steel when the concrete takes no tension, as at an accidental joint. Sections were investigated for controlling load conditions with reference to both of the criteria, but it was discovered that, in general, the design for steel to take all of the stress met also the condition imposed as to stresses in concrete and steel when acting together.

Study of the test sections, interpreted with respect to other observations on behavior of concrete showed, among other things, the particular importance in these structures of keeping concrete thoroughly wet until set. If the concrete is allowed to set dry, shrinkage is likely to produce initial tensile stress in it, with a corresponding compression in the steel, which acting together with the load stresses may break the concrete. Even with the best of management, the initial stress in the materials, due to shrinkage of the concrete, is an uncertain factor which must in the design be recognized in determining the quantity and distribution of materials.

It is highly desirable to cast the concrete of structures designed to hold water against a smooth metal form, because the surface skin which is thus formed is highly resistant to the passage of water. Some laboratory tests made in connection with this and other work indicated the value of the two surface skins on 1 to 7½ concrete in resisting the passage of water to be equal to many feet of concrete. The relative value of the surface skin would undoubtedly be less with a concrete richer in cement, but, nevertheless, the conclusion is warranted that the tightness of a concrete pipe depends in large measure upon the continuity of the surface skins, particularly the interior one. Screenings were found not as satisfactory as natural sand in producing a uniformly dense concrete with a good surface skin.

Brief study of the conditions made it clear that two rings of steel would be advisable to care for such varying internal stresses as would be produced by normal

loading, and because the sections would have a greater stability range for accidental or abnormal loadings than would a section with a single bar on the tension side as determined for some particular loading. The section presented for analysis of stresses was essentially a masonry ring with transverse steel bars embedded near the inner and outer surfaces (see cross-sections, Fig. 1). The steel is everywhere covered by a nominal thickness of not less than 4 in. of concrete. This concrete cover, which may appear excessive when compared with good reinforced-concrete design for some conditions, is believed to be justified in these water-carrying structures, in order that there may be a sufficiently ample concrete protection for the steel after reasonable allowance for unavoidable inaccuracies in placing. The shape of masonry section and relation between concrete and steel areas for least cost of the structures had to be determined by comparison of trial sections. In each case, several possible loadings had to be independently investigated to discover the critical condition. The design of these preliminary sections, was, of course, perfected only to the extent necessary for the purpose.

The method adopted for stress determination was largely a graphical one. Force lines, the resultant of internal and external loadings, including the weight of the masonry, were drawn in the usual way on the sections; that one of these force lines which fixes the position of the center of internal stress in the materials being determined by applying the "least work" criterion, in accordance with the theorem of Castigliana. This theorem, as here applied, recognizes that the distribution of internal stresses in a stable, elastic rib supporting external forces will be such that the aggregate work performed by the internal forces, or stresses, is a minimum. In these sections, the internal forces were in all cases so nearly symmetrical about the vertical axis that the direction of the resultant at middle of crown and invert could be taken as horizontal in direction. The position of the true line had to be sought by the laborious "cut and try" process, but experience soon gave such adeptness that a line could generally be determined nearly enough for practical purposes in three or four trials.

Registering Apparatus

The registering, indicating and recording machines for these meters are equal to the highest development of this apparatus. A large indicating dial shows the rate in gallons per day. This will be particularly useful in regulating flows in the aqueduct to the desired quantity. The counter dial will show total gallons which have passed the meter. This feature is similar to the dial of an ordinary water meter. The recorder dial holds a paper chart which gives a continuous autographic record of rate of flow, useful as a permanent record of intended or accidental fluctuation in flow, and may serve as a record independent of the counter of the total gallons which have passed the meter. Bronze, aluminum and other noncorrosive metals are used largely in this apparatus, and it is otherwise designed by the manufacturers for reliable and continuous service.

Construction of Venturi Meters in Open-Cut Aqueduct

As the three meters in open-cut aqueduct are practically identical in design, and the methods of construction are much alike, the construction of the Kensico meter, located just below Kensico Reservoir, will be described as typical of all. The first attack was the building of a short piece of double-barrel culvert long enough to support the meter over it and provide permanent control for the flow of the stream during construction. This work was done in the fall of 1911, as was also the assembling of the throat castings, and the building of the walls of the register chamber supporting them. The construction of the rest of the meter, and its approaches, spread over the entire working season of 1912. Fig. 1 shows the details of the meter and recording chamber and Figs. 2 to 9 are views of the meter during construction.

An interesting feature of the earlier construction, the support of the heavy bronze throat castings while erecting forms, placing steel and depositing concrete, is shown in the views, Figs. 2 and 3. The longitudinal timbers of this support are carried on crib work entirely outside the limits of the concrete cast to be made for the support of the throat castings and for forming the sidewalls of the register chamber. The throat castings were assembled and braced with care before the forms for the adjacent section of the meter tube and for the sidewalls of the chamber were built. Just before the placing of the concrete, slight defects in alignment and elevation were corrected and additional bracing placed. After the concrete forms were removed, the castings were found to be very close to the desired position.

While setting the throat castings, it was discovered that the two sections when assembled did not match as to interior shape by as much as ⅛ in. Inquiry developed that there had been no such defect in these castings before shipping from the foundry. Careful measurements of the sections indicated that both of them had been slightly distorted, due probably to handling in transit. Ordinary jack screws were applied to the short diameters, and by careful manipulation, the two castings were brought to practically perfect circles, and made to fit so closely that the joint between them was barely evident to the touch.

To prevent foreign materials from entering the piezometer chambers, and to preserve the sharp edges of the piezometer holes from injury, a stout wood protection was built over them and preserved during the construction period.

Throughout the meter proper and the approaches thereto, the work was built in sections of approximately 15-ft. length, measured on the center line of the waterway and, with the exception of the cradle portion, the concrete (Fig. 4) was cast monolithically. This necessitated support of the inside forms which was accomplished by constructing support blocks (Fig. 1) of concrete ahead of the placing of the forms for each section. The support blocks were made with offsets on their ends and sides to form waterstops and to insure greater stability through spreading of the base. There were four support blocks built under each section, spaced 3.75 ft. apart and so placed as to leave equal lengths of form projecting at each end.

Before placing the order for the steel rods, stations on the center line were established for each rod and the required lengths of rods computed. In the subsequent placing of the steel the stations previously established for each rod were adhered to and every effort made to place and hold the rods in their proper positions.

The inner rods being circular in shape, were bent satisfactorily by wrapping them about a wooden cone. This was done by a gang of men inserting one end of the rod to be bent under a clamp at the proper point on the cone, then, holding the rods in the hands, the men walked around the cone keeping the rod in such a position that it traced a true circle on it. In order to make a good lap, with proper curvature of the rod, it was necessary, after bending from one end, to insert the other end and bend for a short distance as before. It was found by trial that, with the quality of steel used, a circle of about two-thirds the required diameter of the bent rod would allow for the spring in the steel and give the desired curvature. A similar form was tried for the outer rods, but for the required shape this method was found not to be feasible. After receiving a rough preliminary bend, the outer rods were laid on a platform and bent with a rail bender to a line inscribed thereon.

Wooden forms were used throughout. The inside forms were built with center ribs 4 in. thick, made by nailing together segments sawed from 2-in. plank. These were braced horizontally and vertically with 4x6-in. timbers. For the truncated-cone portions (Figs. 3 and 5) the station and proper diameter for each center were established in advance and all the centers made up. As the work progressed, the centers for each section were erected in their proper relative positions on a platform and 2-in. lagging beveled on each side to aid in forming a smooth curve, nailed to them, the outside surface calked and planed, and the form oiled and swung into position with a derrick. Each set of lagging was used a number of times on successive casts.

For the 17-ft. diameter sections, the inside forms were made with centers similarly constructed but built in two halves and erected with longitudinal key timbers strutted into place so that in order to draw the forms it was only necessary to knock out these struts and remove the form in two pieces.

The outside forms and bulkheads were built in place for each cast and were made up of 2-in. ribs and lagging with 10x10-in. wales at the bottom and at the horizontal diameter. Spaces were left in the outside form to permit spading from the outside—one opening being at the bottom, another just above the horizontal diameter and a third at the top. The first two mentioned were filled with lagging as fast as the concrete reached their elevations. Openings were also left in the bulkheads to enable men to get within the forms. Inside and outside forms were tied together with wires, which were cut back from the face of the concrete after removing the forms and the hole stopped with mortar. No interior counterweighting of forms was found to be necessary.

It was found to be advantageous to drill 1-in. holes between each rib through the inside forms. These holes were used as telltales to establish the fact during the progress of the work that concrete was filling the entire space under the form.

All concrete used was mixed in Ransome mixers at a plant 1200 ft. away, and conveyed thence in bottom dump buckets on flat-cars to the work and there rehandled by means of a small guy derrick. The mixture used was 1 to 8 for mass concrete and 1 to 6 for reinforced work.

In depositing the concrete, it was found here, as on other similar work, that there was a distinct advantage in having a platform built over the top of the form to dump upon. The platform as used on the meter cast had a hip in the center and removable side boards. This form of platform made possible the absolute control of the amount of concrete being placed at any one point, kept the rods and top of the form clean and by keeping boards on one side at a time made it possible to work with safety inside the cast on the opposite side. This last was an important feature as it was practically impossible to prevail upon the men to stay inside the cast if, through carelessness, concrete was likely to be dumped upon them, and their presence there was absolutely essential to good work.

After the excavation and construction of the cradle and support blocks, the form was swung into place on the support blocks by the derrick. Then the requisite number of inside and outside rods were threaded over the inside form and distributed between the support blocks in proper proportion by lifting the end of the inside form and passing the rods between it and the support blocks. When the rods were all distributed, they were secured in proper positions by bolted wood clamps. Three of the clamps were placed on each rod—one at the top and one on each side. The rods were then wired to the 1¼-in. tie-rods and the clamp left on all the rods at the top but only upon every third rod at the sides.

At the commencement of concreting, the side boards on the dumping platform on the top of the forms were removed on one side and a number of batches dumped. Boards were then removed on the opposite side and the first boards replaced and the same number of batches dumped. In the meantime, the men on the first side crawled inside the form and spaded thoroughly the concrete placed. This process was continued throughout the cast until the space between the inside and outside form became no narrow that it was advantageous to dump a bucket on the center of the form and allow it to spread equally on each side. Owing to the close spacing of the rods, 7½ in. c. to c., and the numerous support blocks, the portion of the cast below the invert was most difficult. It was found that there was a tendency toward separation of the stones and the mortar in the early stages of the work, the stones falling on the outside of the cradle and mortar flowing around the form toward the center. To correct this, sloping boards were introduced just above the top of the cradle and just outside the outside rods. The falling concrete struck these boards and was shot effectively under the inside form. In spading the lower portion of the work it was found that a round-pointed bar was the most effective tool to use in dislodging the dams of stones that would form under the rods and about the support blocks. This would dislodge the stones without becoming entangled itself, as flattened rods or spades did. As the concrete approached the invert elevation, the holes on the inside of the form were carefully watched and as fast as rich concrete appeared they were plugged. In numerous cases, extraordinary efforts were necessary in the vicinity of a hole in order to produce a satisfactory result.

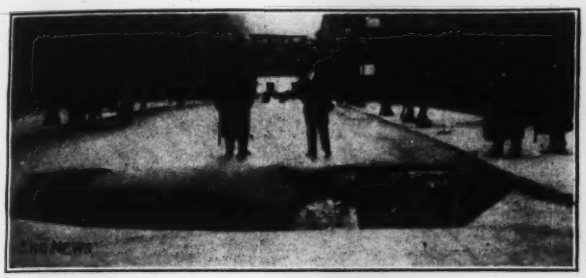
Throughout this work, three things were recognized as of particular importance: careful bending and placing of steel, thorough mixing of concrete and efficient working and spading within the forms—care being taken not to allow more concrete dumped in any one place than could be properly worked. Until the concrete reached the height of the horizontal diameter on each side, it was

found important for best results to have two inspectors on the work, one on each side.

The Board of Water Supply which is building the Catskill works consists of three commissioners: Charles Strauss, president, Charles N. Chadwick and John F. Galvin. J. Waldo Smith is chief engineer. Designs and specifications for the meters were prepared by Headquarters Department of the Engineering Bureau, of which Alfred D. Flinn is department engineer. The meters have been, or are being, constructed under the supervision of the several field departments by contractors for portions of the aqueduct, and other structures in some of the contracts for which one, or more, of the meters are included.

Broken Water Mains Flood Sub-Surface District, New York City

Two water mains—a 12-in. and a 6-in.—on 33rd St., just west of Fifth Ave., New York City, broke at 4 a.m., on Apr. 13, flooding the two Long Island R.R. tubes, which are under 33rd St. near this point, the subcellar of the Waldorf-Astoria Hotel, the elevator pits of the Cambridge Building, and the cellar of the Security Bank.



STREET DAMAGE BY BROKEN WATER MAINS

The accident was reported to the W. 30th St. Police Station at 4:10 a.m., and complaint was received by the repair station of the Water Department at 4:45. An emergency force cut off the water and removed the damaged pipes. The water supply of the vicinity was not interrupted.

The water in the railroad tunnels, which is reported to have reached a maximum depth of 2½ ft., was pumped out as soon as the broken mains were cut out. Traffic through these tubes is lightest at this hour and was but little interrupted.

The hole in the street, shown in the cut, is about 40x40 ft. by 15 ft. deep. The paving on 33rd St. is asphalt.

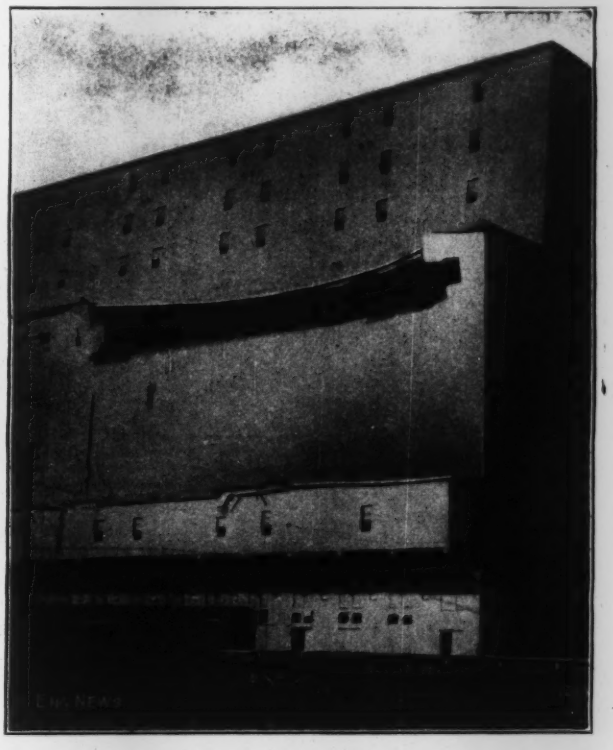
A Grain-Elevator Explosion at Galveston, Texas

An explosion seriously damaged a large grain elevator at Galveston, Tex., on the morning of Mar. 30. The explosion was followed by a burst of flames, but the fire was controlled by the automatic sprinkler system.

The main damage occurred on the bin floor directly under the roof, as shown in the cut. About 300 ft. of the exterior walls were ripped out, and 200 ft. more bulged out on each side of the break. These walls were constructed of 2x6-in. studding, spaced 20 in. on centers, and covered with 1-in. sheathing, to which heavy corrugated-iron sheeting was nailed.

According to those present, there was first a muffled roar, accompanied by a flash as the upper part of the building appeared to bulge out in a cloud of black smoke or dust mingled with sheets of flame. This was followed immediately by a deluge of water. The sprinkler system acted instantaneously, quenching the fire.

There are many exposed lighting wires throughout the structure, but investigation shows them to be in good condition.



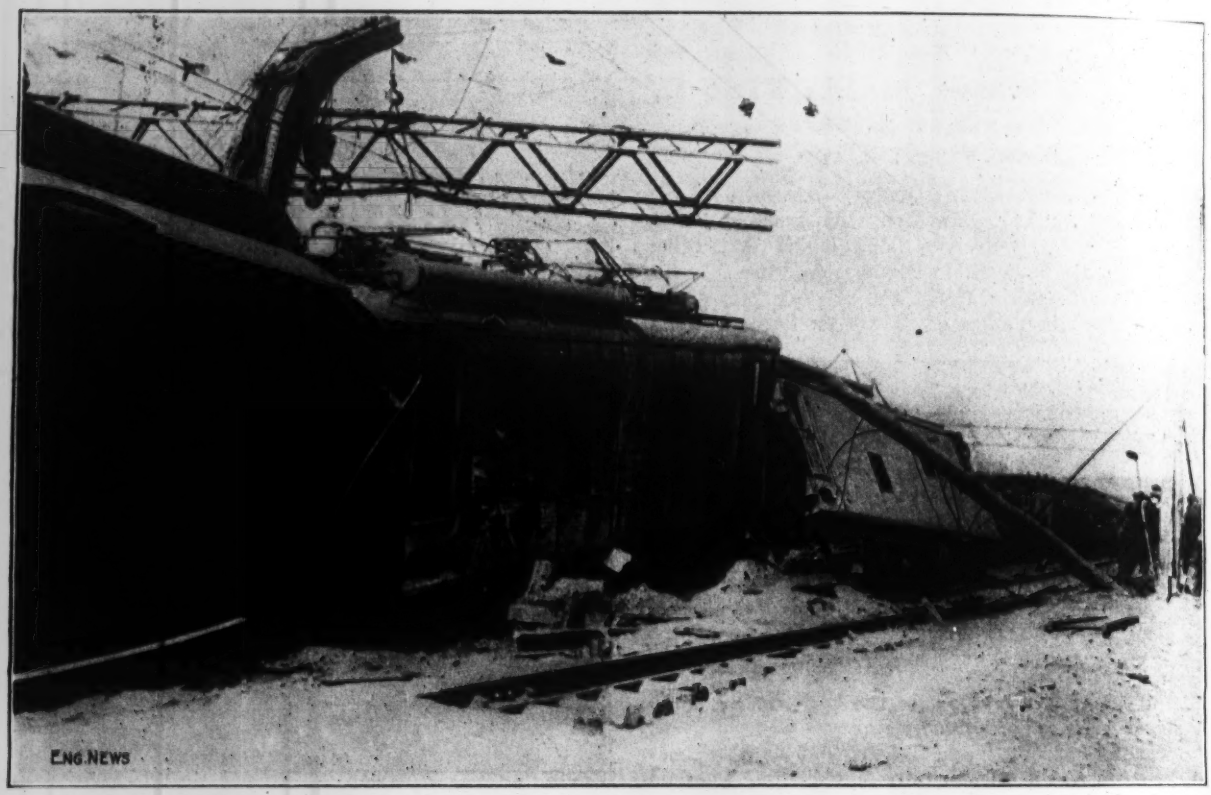
SHOWING THE LOCATION AND EXTENT OF THE GRAIN-ELEVATOR EXPLOSION AT GALVESTON

The elevator was built in 1903 at a cost of about $350,000, and at the time of the explosion contained 80,000 bu. of grain, of which about 10% was damaged. The damage to the building amounts to about $3000. No machinery was injured, nor was anyone hurt.

Sewer Stoppages by Tree Roots at Brazil, Ind., have caused much trouble for the past eight years. In nearly every case of stoppage thus far remedied, we are informed by Fred C. Wilson, City Engineer, it has been necessary to take out the sewer pipe to remove the roots. To obviate further difficulty of this sort the City Council has passed an ordinance prohibiting the planting of North Carolina and silver poplars, the kinds of trees giving the most trouble, within 100 ft. of any storm or sanitary sewer. We understand that cottonwood trees are also included in the ordinance. The ordinance also requires the cutting down of such trees as exist within the same distance. Very little difficulty is experienced in the enforcement of this ordinance after the property owners realize the damaging effect of the tree roots in the sewers and in wells also.

A Derailment in the Electric Zone of the New York, New Haven & Hartford R.R.

The first serious derailment in the electric zone of the New York, New Haven & Hartford R.R. occurred Sunday, Apr. 12, about a mile east of Harrison, N. Y., or about 25 miles from New York City. There were no casualties, no passenger was injured beyond a few bruises, and even the motorman of the double locomotive escaped without further injury than cuts and bruises.



(Courtesy of N. Y. "World.")

DERAILED ELECTRIC TRAIN, N. Y., N. H. & H. R.R., NEAR HARRISON, N. Y.; SHOWING WRECKED CATENARY TROLLEY SYSTEM

The train, known as the Green Mountain express, was traveling eastward at a speed of approximately 50 miles per hour. It was drawn by two electric locomotives (described in ENGINEERING NEWS, of Dec. 31, 1908, and previous issues) and was composed of two all-steel mail cars, a wood combination baggage and smoking car, three wooden day coaches and two wooden Pullman cars.

Soon after passing a long curve (about 2°) to the right, about 9 a.m., the motorman became aware that the leading locomotive was derailed, and before the train could be brought to stop both locomotives and the first four cars had left the rails.

The derailment occurred on the outer of the two eastbound tracks, and two of the steel towers from which the catenary trolley wires are suspended were wrecked. The first tower was knocked off its concrete base but apparently did not entirely collapse. The locomotives hit the next tower squarely and entirely demolished it, [illegible] the feed wires which were carried on crossarms [illegible] and automatically cutting off the current sup[illegible] the power house at Cos Cob, Conn. The [illegible] wrecked tower, and the overhead bridge car[illegible] catenary trolley wires suspended by a wreck[illegible] are shown in the accompanying view.

The cause of the derailment is not known at [illegible] writing, but it is supposed to have been due to the [illegible] of a flange or the dropping of some part of the [illegible] locomotive. From the manner in which the t[illegible] cut up it is apparent that the wheels of the po[illegible]

of locomotive were derailed for a considerable distance before the motorman realized that anything was wrong.

The accident tied up all electric traffic over the division for six hours, or until 3 p.m.; but the damage to the catenary trolley system was not so serious as might have been anticipated from the character of the derailment. Considerable difficulty was experienced, however, in setting the derailed locomotives and cars on the track, due to complications in working the wrecking cranes under the network of wires, especially after the power wires on the side had been restrung and the danger of accidental contact with them made the wrecking work hazardous.

The section of the railway where this accident occurred is operated by simple-phase electric power transmitted at 11,000 volts. The trolley line is of the "double catenary suspension" form. (For description, see ENGINEERING NEWS, Mar. 22, 1906).

The Detroit Gas "Explosion" of April 6

Newspaper reports of April 7 gave prominence to a so called gas-tank explosion in the story and a half brick warehouse of the Detroit Blaugas Co., which, it was reported, severely burned two men, slightly injured three more and endangered a considerable portion of the business district.

A correction of these somewhat exaggerated reports has been received from G. J. White, Gas Inspector of the Department of Public Works. It appears that a careless workman carrying an open lantern entered the storage room, where about a hundred gas-filled tanks were stored. A leaky valve on one of the tanks had allowed an explosive mixture to accumulate in the room. The explosion set fire to the building and the heat from the fire expanded the gas in the tanks until they were under sufficient pressure to allow the relief valves to open, when the gas stored in the tanks added fuel to the flames. These tanks are filled to 1500 lb. pressure and the safety valves are set to open at 2200 lb. None of the tanks exploded, but, of course, the gas all escaped and made a serious fire in the heart of the business district.

Blau gas, it will be recalled, is a petroleum gas, compressed to liquid state and confined in tanks for the supply of isolated lighting and heating equipment. This accident shows the danger of carelessly handling this compressed gas; however, it should also be a noteworthy illustration to the popular mind of the fact that a gas fire, in the absence of a supply of explosive mixture with air, does not necessitate disastrous explosion.

Developments in the Philadelphia Rapid-Transit (Subway) Situation

At a meeting of the Committee on Rapid Transit of the Philadelphia City Councils, Mar. 25, 1914, the Philadelphia Rapid Transit Co. submitted a proposal for the operation of the projected new lines. At the same meeting, the Director of the City Transit Department, A. M. Taylor, presented a tentative counter proposal.

The company proposed to build and equip an extension of the present Market St. elevated-subway road to Frankford (northeast of the city) at a cost of $8,912,000 and to secure control of a tunnel under the Delaware River to Camden, N. J. (costing $6,000,000 in 5% bonds); the City would build and equip the Chestnut St. (east-west) subway and the Darby elevated extension (southwest of it) at a cost of $14,855,000; the City would also build and equip the Broad St. (north-south) subway at a cost of $42,075,000. The company proposed to operate these City-owned lines, deducting from net earnings a preferential payment for the decrease in the company's net income below that of the year prior to the operation of the City-owned lines, and also deducting interest and sinking-fund allowances (cumulative) on the city investment, dividing the balance of net earnings between city and company.

The company also proposed to discontinue 3c. exchange tickets and, outside a central delivery, would give universal free transfers between rapid-transit and surface lines. The company asked for compensation for loss in revenue from 3c. exchange tickets ($794,000) that its 1907 contract with the city be amended by (1) a seven-year extension, (2) waiver of annual payments in lieu of paving repair and license fees (some $500,000 and of taxes on dividends of subsidiary companies (about $116,000) and (3) suspension of present sinking-fund payments ($120,000) for ten years and thereafter graded to extinguish par value of company's stock in 40 years.

The Transit Commissioner's counter proposal provided that the company build and equip the Frankford elevated extension, at an expense of $8,912,000, and furnish the equipment for the Broad St. subway, the Chestnut St. subway and the Darby elevated extension at $9,834,000, besides securing lease of the tube to Camden. The City would build, but not equip, the Broad St. and Chestnut St.-Darby lines at an expense of $34,682,000 and $12,810,000, respectively. The company would operate the City-built lines, deducting from annual net earnings (1) 6% cumulative interest on the City's investment, (2) a preferential payment, to the company for the first five years' operation of each City-built line, equal to the net decrease in the net income of the company derived from surface and rapid-transit lines below that for the year ending June 30, 1914, and due to diversion of traffic due to City-built lines—such preferential amounting to no more than $500,000 in any one year; (3) interest and sinking-fund allowances (cumulative) on the City's investment. The surplus net earnings left would be divided in proportion to the relative investment of City and company.

The Commissioner further proposed free transfers between all surface lines and new rapid-transit lines. The company would run the Frankford-Chesnut-Darby lines as a through system dividing the fare of transfer passengers with surface lines 3c. to 2c., respectively. Additions and extensions of the rapid-transit lines would be operated on the same basis. The Commissioner would extend the 1907 contract for 7 years, making the division of earnings for the last seven years all over 6% on par value of company stock.

The Commissioner claims that the department scheme reasonably protects the company against loss of present net earnings due to the operation of new city lines, while permitting but not insuring large increases in gross and net revenue, and provides the City a fair basis for constructing high-speed lines with power to develop such facilities as may be needed. He claims that the compensation for loss of exchange-tickets sought by the company would amount to from $623,000 to $1,029,000 per year for 50 years, while the exchange tickets themselves constitute an illegal, unjust and discriminatory charge that may be set aside by the Public Service Commission.

Municipal Coal Yards in Maine may be legally established for the purpose of selling coal and other fuel at cost, according to a decision of the State Supreme Court handed down on April 6. In passing upon the validity of the legislative act authorizing municipalities to sell coal, the court said:

> It is sufficient to say that we see in this act of the Legislature a sign neither of paternalism nor of socialism. We do not regard it as a departure from previous legislation, but in line with it, although perhaps one step further. The direction, however, is the same, and the advance is caused by the development of a new want which has called for a new exercise of legislative power, not an exercise of new legislative power, and such an advance is both legitimate and commendable.

Notes from Engineering Schools

KANSAS STATE AGRICULTURAL COLLEGE—The Board of Administration has established a highway engineering course to begin next year. The course is offered as an option for students in civil engineering. The college year is divided into three terms. Five hours of strictly highway work will be given in the second term of the sophomore year, besides ten hours in the first term, four hours in the second term, and ten hours in the third term of the senior year.

W. S. Gearhart, State Engineer, has been appointed Professor of Highway Engineering in charge. Most of the instruction will be given by L. E. Conrad, Professor of Civil Engineering, though some of the practical subjects will be handled by Mr. Gearhart and his assistants.

The Board also established a ten weeks' short course in highway engineering for county engineers and surveyors, to be given during December, January and February.

OHIO STATE UNIVERSITY—A short course in industrial arts has been planned for persons working in manufacturing lines, who have not been able to take technical studies in a regular engineering course. It gives a chance to get fundamental technical knowledge and training under good, practical instructors. It is intended to put men in line for better positions and more responsibilities.

The course will start in September and close in June. Candidates for admission must be (1) age of 21 years and ability to read, write and compute, or (2) age of less than 21 years and two years of practical shop experience.

UNIVERSITY OF WISCONSIN—The engineering courses of study have recently been modified. (1) A reduction has been made in the amount of work required, especially in the first two years. (2) An increase has been made in the number of elective hours in the later years of some courses. (3) Students, who have had three or four years of foreign language study, may omit that subject from their courses. In that case, english prose style is substituted in the Freshman year; students studying a foreign language in that year take this English work in their third year while the others take advanced work in their own or allied fields for the third and fourth years. Those having to study foreign language in their course thus lose one year of advanced work in some technical subject. The "shortened hours" of the first two years show 18 to 20 "credit" hours equivalent to some 24 hours actual time on account of double laboratory hours, etc.

NEWS NOTES

A Broken Water Main Flooded the LaSalle St. Tunnel in Chicago, Ill., on Apr. 7, to a depth of 8 ft. A 36-in. water main was known to be leaking and when the street was opened to repair the pipe, it burst. The water-department wagon sank through the street and water rushed through a hole into the tunnel and also entered the tunnel through the northern portal. Two street cars in the tunnel met the entering water and were compelled to turn back to the southern portal. The valve was closed as soon as possible and catch basins to the sewer were opened and the water pumped from the tunnel.

A Flood Wrecked a Flour Mill at Osage, Minn., on Mar. 31. The mill was valued at $15,000. The Straight River flood is quite serious, damaging bridges, fences and highways.

A Steam Shovel Struck a Missed Hole, at the Celilo-Celilo government canal works near Big Eddy, Ore., on Apr. 8, causing the death of the steam-shovel operator and injuring about 20 others. According to press dispatches the accident followed a series of protests, one in the form of a signed petition, from the workmen, complaining that missed holes were frequent, due to the carelessness of the drill bosses.

An Explosion Damaged the Factory of the Ecli... Vulcanizing Co., in Brooklyn, N. Y., on Apr. 9. According to press reports a large pot containing a preparation for reducing rubber exploded, wrecking the second floor of the building, but injuring no one.

A Sidewalk Grating Collapsed in uptown New York on Apr. 10, injuring five persons who fell a distance of 12 ft. The grating was in front of a store whose windows displayed a page of news pictures which attracted too great a load for the grating to support.

Scoured Piers Cause a Wood Trestle to Sag—High water at Nanticoke, Penn., on Mar. 30, undermined the foundations of two bents of the long Pennsylvania R.R. trestle between Nanticoke and West Nanticoke, causing one side of the trestle to sag 5 ft. below the other side. Railroad traffic was stopped, but vehicles and pedestrians were allowed to use the bridge.

Sewer Gas Killed Three Workmen who had gone into a sewer in New Bedford, Mass., on Apr. 10, to break down a bulkhead.

A Wreck Remarkable for Its Small Casualty List occurred on the New York, New Haven & Hartford R.R., at Clayton, Conn., on Apr. 11. The locomotive and three cars turned over on their sides; the fourth car was derailed but remained upright. Not one of the 140 passengers was badly injured; the fireman was killed. The train formed a part of the half-hour service between New Britain and Hartford, Conn.

A Model of the Baltimore Sewage-Treatment Works has been prepared by Calvin W. Hendrick, Chief Engineer of the Baltimore Sewerage Commission, for and at the expense of the U. S. Government, and is now on exhibition in the Army Department at Washington, D. C.

Alleged Damages from Trade Wastes discharged into the Passaic River by the United Piece Dye Works, of Lodi, the Hammerschlag Manufacturing Co. and the New Jersey Worsted Spinning Co., of Garfield, are the basis of damage claims to the extent of $600,000 asked by the Passaic Investment Co. and Jos. T. Bunting, of Passaic, in a suit recently brought in New Jersey.

A Locomotive Speed Signal is being introduced on the Baltimore & Ohio R.R., which road uses speed recorders on many of its locomotives in through and local service. With the new attachment a gong is sounded and a flashing light displayed in the cab when the engine speed exceeds the prescribed limit. The apparatus is the invention of Charles Edmonds, a mechanic in the railway company's shops.

The Relation of Stream Obstruction to Floods is to be studied in the Mechanical Engineering Laboratory of the Ohio State University. A pump with a capacity of 14,000 gal. per min. will deliver water "through a long flume in which obstructions are arranged so as to produce as far as possible flood conditions of flow."

Cotton Warehouses and River Terminals at New Orleans are to be built by the Board of Port Commissioners with the proceeds of a $3,000,000 bond issue which has just been taken by New York bankers. The project comprises the warehouses, wharves and terminal railway involved in the complete development of a cotton-handling plant which will be the largest of its kind. Ford, Bacon & Davis, Engineers, have been retained as designing and Constructing Engineers.

The Irrigation Conference at Denver, attended by Governors of Western States, Federal officials representing the Interior Department, and others interested in irrigation matters, adopted the following resolution on April 10:

"Resolved that this conference indorses the Newlands Broussard River Regulation and Flood Prevention Bill and urges all Senators and Representatives from the West in the Congress of the United States to solidly support said bill and to unitedly declare their support therefor without delay."

An Order to Install a Water-Filtration System at Sedalia, Mo., has been issued against the City Water Co., of Sedalia, by the Public Service Commission of Missouri, under date of Feb. 24, 1914. The company is given only until July 1, 1914, to have the plant completed and in operation, and this notwithstanding the fact that plans and specifications for the

improvement must be submitted in detail to the Commission and receive its approval. The company is also directed to "provide for having continuous bacteriological tests of both raw and filtered water." T. M. Bradbury is Secretary of the Missouri Public Service Commission with offices at Jefferson City, Mo.

The Miami Conservancy District Project for flood prevention at Dayton, Ohio, and vicinity, we are informed by the Morgan Engineering Co., is still in suspense. On Apr. 16 the Conservancy Court will hold an informal conference and will then, it is expected, set a date on which they will reconvene to render their decision on the constitutional questions which have been raised as to the formation of the proposed district. Whatever the decision then given it is probable that an appeal will be taken to the higher courts.

Paving-Brick Manufacture By Convicts in New York State—In accordance with the request of Governor Glynn in his special message to the legislature, Mar. 23, reprinted in our issue of Apr. 2, p. 752, a law has been enacted appropriating $75,000 for a paving-brick manufacturing plant at the Elmira state reformatory. Samples of Chemung shale, deposits of which are abundant near Elmira, have been sent to various brick-making concerns for tests. The State Highway Commissioner, John N. Carlisle, is quoted as saying that he expects the plant will be in operation this season.

Results of Civil Service Examination for Senior Structural Engineers, Division of Valuation, Interstate Commerce Commission, have recently been received from our Washington correspondent. The number passing the two grades are given below:

	Grade 1			Grade 2		
	91-100%	81-90%	71-80%	91-100%	81-90%	71-80%
District 1	7	15	7	1	12	13
2	1*	8	1	—	3	1
3	2	4	1	1	6	4
4	1 and 1*	3	3	—	1	2
5	2 and 1*	3	—	—	4	3

*Appointed.

Cabbage Hill Reservoir, Pittsburgh, Penn.—For some years the city of Pittsburgh has had the benefit of filtered water, but the North Side, formerly the city of Allegheny, has been obliged to use raw water from the Allegheny River. There is now in the course of construction a new distributing reservoir to be known as the Cabbage Hill reservoir, which is to have a capacity of 150,000,000 gal. From here filtered water will be distributed over the entire North Side. Concrete is extensively used in its construction, and the cost will be approximately $1,000,000. To supply the reservoir with water from the Brilliant filtration plant, a new high duty pumping station has been built at Aspinwall, containing a 100,000,000-gal. pump.

A Municipal Tour in Europe will be conducted during the coming summer under the auspices of the Intsitute of Educational Travel, 1 Madison Ave., New York City. The party will sail from New York City on July 1 and is due in New York on its return on Sept. 4. According to a printed announcement:

> The itinerary will include Copenhagen, Berlin, Dresden, Munich, Ulm, Frankfort, Düsseldorf, Essen, Amsterdam, Brussels, Paris, London, Liverpool and many others—cities which in city planning, rapid transit, industrial development, building regulation, wholesale and retail markets, public health, educational methods and the broad policies of municipal ownership, including land, houses and public utilities, are worthy of the fullest study and understanding by American citizens and municipal officials.
>
> Further information regarding the trip and the leaders of the party may be obtained from the Institute at the address given above.

A Railway Terminal Commission at Chicago is provided for in one of the ordinances passed by the City Council on Mar. 23 relative to the new union station and other terminal works. The commission is to consist of seven members appointed for one year by the mayor, but two of these are to be appointed on recommendation of (and to be paid by) the Citizens Terminal Plan Committee and one on recommendation of (and paid by) the Chicago Plan Commission. The duties of the terminal commission will be to make a comprehensive and expert study of the passenger and freight terminal station and its problems, with regard to present and future conditions. It is understood that this will include the questions of electrification and smoke abatement. The commission has not been appointed as yet.

Proposed New Municipal Market, Pittsburgh, Penn.—Plans have been prepared and tentatively adopted for a market house to be built on the site of the present old market. The approximate cost of the building will be probably $300,000. The first floor will contain approximately 11,000 sq.ft. of space, the building having a roadway through the center of the first story. On this floor will be stalls for meat and fish markets. On the mezzanine floor are arranged cold-storage rooms for the stall holders. The second floor will cover the entire lot, 22,000 sq.ft., and will contain room for the general market. Commodious elevators will care for the customers wishing to shop in the general market. In addition to the machinery for operating the elevators, there will be heating and refrigerating plants. Owing to some opposition, the plans as now drawn are temporarily held up. However, the project will in the near future be pushed to completion, although the present plans may be modified. Messrs. Rutan & Russell, of Pittsburgh, are the architects.

An Experimental Sewage Treatment Station for Erie, Penn., has been demanded by the State Department of Health before the final approval by it of plans for sewage treatment submitted by the city. An appropriation of $8000 is available for the experimental plant, but title for the land for both the experimental and permanent plant is disputed by a railroad company. Work on neither plant can proceed until the case has been decided by the higher court. Erie has a population of about 80,000, and is provided with about 90 miles of sewers, almost wholly on the combined plan. The average daily dry-weather sewage flow is 12,000,000 gal. Intercepting sewers are now being built to take the dry-weather flow from all sewer outlets to the site of the proposed treatment plant. The plans for the treatment works, prepared several years ago, provide for a screen and grit chamber, and a battery of six Imhoff tanks working in pairs, with provision for reversed flow and about 40 minutes sedimentation. The effluent would pass to Lake Erie through a conduit about 7000 ft. long and be dispersed through a lineal distance of 140 ft., in a depth of water of 26 ft. For the foregoing information we are indebted to B. E. Briggs, City Engineer of Erie.

A Joint Outlet Sewer and Sewage-Treatment Plant for the city of Plainfield and the borough of North Plainfield, N. J., will probably be put under contract early in June. The sewer will have a diameter of 42 in. and the sewage works will provide for a population of about 40,000. Plans for these works were prepared by the firm of George W. Fuller, New York City, in August, 1912. In due season they were approved by the New Jersey State Board of Health, which previously had declined to approve plans for similar treatment works for the individual needs of Plainfield and North Plainfield, respectively. The State Board of Health also declined to approve of a joint plan other than at the site known as the "Darling Farm," situated in Piscataway Township and in what has very recently become the Borough of Middlesex. Nearly a year was occupied by these communities in authorizing the various steps needed to form a "Joint Meeting" under the laws of 1910, Chap. 112, whereby the needed works will be built jointly. Contracts authorizing the formation of this joint meeting were signed on Nov. 4, 1913, and several months have been occupied in purchasing about 90 acres of land known as the Darling Farm. On Apr. 8, 1914, the firm of George W. Fuller was engaged as engineers to supervise the construction of the outfall sewer and treatment works. The latter comprise two-story settling tanks of the Imhoff type for both preliminary and final sedimentation, together with sprinkling filters having an aggregate area of 1.75 acres.

Ten-Inch Bridge Pin Replaced by 13-In. Pin—On Sunday, Apr. 12, 1914, a 10-in. pin in the stiffening truss of the Williamsburgh Bridge over the East River, New York City, was taken out and a 13-in. pin set in its place. The operation was in all respects successful. The pin forms the connection between the stiffening truss of the 1600-ft. suspended span, and the truss of the (not suspended) land span adjoining; it is located about 20 ft. landward of the main tower, as the stiffening truss cantilevers over by this distance and receives the end reaction of the land span on the cantilever end. In the recent strengthening of the bridge to prepare for heavy subway-train traffic, various parts of the land spans (two spans on each side) were found weak, among them the connection pin in question, a 13-in. pin being required here in place of the 10-in., even after reducing the land-span reaction by other changes.

The pin is in the lower chord. To take the load off it, an extra cantilever of the stiffening truss was built, with upper horizontal tie and inclined struts to the main tower, and with a heavy transverse truss seated at its outer end, over the roadway. Screw-operated wedges set on this truss engaged the trusses of the land span; by operating these wedges, load could be taken off the bottom-chord pin, in predetermined amounts. When the bottom-chord pin was entirely relieved of load, however, it could not be driven out, though only 28 in. long. Thereupon four 2-in. holes were drilled longitudinally through the pin, the intervening webs broached out to collapse the pin, and the halves drawn out. A specially built drilling machine (Fawcus Machine Co., Pittsburgh), set upon a bracket attached to the truss, then bored out the pin-hole

to 13 in., in two cuts. Then the new 13-in. pin was slipped into place.

During the operation, i.e., between removal of old and placing of new pin, the four members meeting at the pin were held in position by two temporary gusset connections.

Canadian Tariff on Structural Steel Increased—An increase of import duty on several iron and steel schedules, to take effect immediately, was announced by Finance Minister White in his annual budget speech before the Canadian House of Commons, on Apr. 6. The change affects all three tariff classifications: The preferential, charged on imports from Great Britain and most of the British colonies; the intermediate, applied in the case of treaty countries, e.g., France, Belgium and Austria; and the general, under which import duties on the United States are levied.

Heretofore structural steel weighing over 35 lb. per yd. has paid $2 preferential, $2.75 intermediate, and $3 general. The increase provides that up to 120 lb. per yd., structural steel shall be taxed $4.25 preferential, $6 intermediate and $7 general, whenever the Government is satisfied that steel of this character can be made in Canada. Tubing of iron or steel up to 4 in. in diameter enters at the same rate as previously: 20% preferential; 30% intermediate, and 35% general. Charcoal for smelting will be admitted free; and bituminous coal, heretofore taxed 53c. per ton, is made the subject of a rebate of duty when imported for conversion into coke for smelting purposes.

Owing to competition in building stone from Indiana and Ohio, the tariff is increased 10% on stone manufactured (i.e., in the way of sawing, planing or dressing).

Wire rods, heretofore free of duty, will be taxed $2.25 per ton preferential, $3.50 intermediate and general.

Engineering Work in Chicago During 1914 promises to be brisk, and it is expected that there will be a large field for the employment of labor. About 170 miles of new road and street work under the Board of Local Improvements is under special assessment and private contract, and the Water Department will probably let contracts for one of the new lake intake tunnels, while the Building Department anticipates greater activity than usual. The Sanitary District has work in progress on the improvement of the main drainage canal, the construction of the Sag Canal, and the north-shore intercepting sewers. Railway work comprises extensive track elevation, including the following: Baltimore & Ohio R.R. and Pennsylvania Lines, from 59th to 69th Sts.; Chicago, Milwaukee & St. Paul Ry.; the Bloomingdale branch from Lamndale to Ashland Ave., and the suburban line (now used by the Northwestern Elevated Ry.) from Wilson to Bryn Mawr Aves.; Chicago, Rock Island & Pacific Ry., 73d to 90th St.; Illinois Central R.R. south to Kensington; Chicago & Western Indiana R.R., on 75th St., from Wood to Union St. This last named road will also carry out the extension and reconstruction of the large freight yard at Clearing, which is intended to relieve the city tracks and yards of much of the through freight handling. Work has been commenced on the reconstruction of the Jackson Boulevard Bridge, and is expected to be commenced on at least one other bridge over the Chicago River. It is possible that before the end of the season work will be commenced on the clearing of the sites for the new union station and freight terminals.

U. S. Government Supervision of Maintenance on the Washington, D. C.-Atlanta, Ga., Road—By a coöperative agreement between the U. S. Office of Public Roads and the American Highway Association, the highway from Washington to Atlanta has been selected for an object lesson in road maintenance, as noted briefly in our issue of Apr. 2, p. 759.

The counties, under this arrangement, are to set aside a sum which, in the opinion of the government engineer in charge, will be sufficient to properly maintain the road for a period of one year. This amount may be either in cash or its equivalent in labor, material and equipment. The money does not leave the county treasuries, but is appropriated by the county officials in the same manner as at present. The agreement provides, however, that it can be expended only under the direction of the government engineer having charge of the road passing through that county.

The Office of Public Roads has assigned three engineers to this project, and the American Highway Association will furnish them with automobile and transportation expenses. They will be employed continuously and will pass over every foot of the road once in each week or ten days. The proposition has been enthusiastically received, and from present indications, every county will coöperate in the manner explained. The engineers are now in their respective districts ready to begin the actual work as soon as the counties have formally ratified the agreement. [Contributed by I. S. Pennybacker, Executive Assistant, American Highway Association, Washington, D. C.]

Twenty-Eight Imhoff Tanks are to be built at the present Baltimore sewage-treatment works as a portion of additional sewage works to treat the sewage from the population of half of the city not yet provided for. We are informed by Calvin W. Hendrick, Chief Engineer of the Baltimore Sewerage Commission, that when he began planning for the construction of the sewerage system of Baltimore there was then available only $10,000,000, or half of the estimated cost of the work. The disposal plant subsequently built and now in operation a few years ago was therefore designed to take care of the sewage of only half the city. Since then bonds have been voted for works to treat the sewage of the other half of the city. (Baltimore now has a population of about 600,000.) The 28 Imhoff tanks are expected to take care of the sewage of about 112,000. Mr. Hendrick states that the first half of the sewage-treatment works was built "along the lines recommended by Hering, Gray and Stearns, with sedimentation and digesting tanks." This installation "is giving very satisfactory results." But as the Imhoff tank which has come into use since the original plant was recommended has given satisfactory results Mr. Hendrick embraced the opportunity of installing Imhoff tanks alongside the old sedimentation and digesting tanks "so that comparisons in construction and efficiency of operation" might be made between the two types of tanks. Bids for the 28 new Imhoff tanks were to have been received Apr. 15.

Free Car Rides Were Given late in March by the Toledo Traction Light & Power Co., for certain of its lines. Franchises were about to expire on these lines and, pending final settlement, the city and company agreed for 3-c. fares in "workingmen's hours." Later the city announced the imposition of 3-c. flat rates. The company claimed violation of the previous agreement and announced that passengers offering 3-c. fares, except during the "workingmen's hours," would be carried free. It is reported that a large and growing majority of the passengers offer the nickel-fare as usual—which is what the company asked for but could not insist on.

To place the status of the car service before the courts, the company applied to Judge J. M. Killits, of the U. S. Circuit Court, for an injunction restraining enforcement of the ordinance. Arguments were heard and, in postponing final hearing, Judge Killits made a statement of the law touching the case, holding (1) that the city had the right to impose reasonable terms for the use of the streets, but that use of the streets by the company could not be held an acceptance of unreasonable terms; (2) that the company could operate without a franchise since its service was a public necessity; (3) that such operation could continue only at the city's sufferance; (4) that the company could discontinue operations; (5) that the court could hold enforcement of an ordinance pending inquiry of the confiscatory effect of its terms.

New Building Code for New York City—A new building code will be prepared by the Board of Aldermen, New York City, under a new plan of procedure. Three revisions of the city's existing building code were drafted at various times in the last six years, by commissions of experts and by the Building Committee of the Board of Aldermen. In each case, however, very strong protests were made against parts of the revised ordinance, sufficient to prevent the enactment of the ordinance. In one case the revision was passed by the Board, but was vetoed by the mayor. Commercial rivalry of materials or methods of construction was involved in most of the protests, e.g. rivalry of tile and concrete floors, etc. The present Building Committee will not make a new revision, but will confine itself to working on the last previous revision, completed by the former Building Committee last fall and reintroduced in January, 1914. To do this on a technical basis it has, under authorization from the Board, approved by Mayor Mitchel, retained Rudolph P. Miller as expert, and Mr. Miller has just resigned the office of Superintendent of the Bureau of Buildings, Manhattan Borough, to take up the work. The plan of procedure is outlined in the following statement of the chairman of the Building Committee:

Mr. Miller's efforts will be directed toward meeting, as far as possible, the objections and criticisms made against the pending measure when it was under discussion last year and those that may still be offered. In this work he is to act in consultation with the Superintendents of Buildings for the several boroughs. He will also be glad to receive from all interested parties and critics such suggestions as they may wish to offer. So far as possible the public will be kept informed of all proposed changes in the draft published in the "City Record" of Jan. 15, 1914.

It is assumed that the draft under consideration, being the outcome of the work of several commissions and private committees, and following the lines laid down by these bodies after discussions at public hearings, represents the kind of an ordinance that the architects, builders and real estate interests feel should be enacted.

Mr. Miller was a member of several previous boards of experts retained by prior aldermanic committees in revising the building code.

PERSONALS

Mr. Frank Carroll has been appointed Manager of the newly opened office of the Ingersoll-Rand Co., in Juneau, Alaska.

Mr. Guy Hopkins, Acting General Superintendent of Morgan's Louisiana & Texas R.R. & S.S. Co., New Orleans, La., has been elected Vice-President.

Mr. William A. Winburn, Vice-President of the Central of Georgia Ry., Savannah, Ga., has been elected President to succeed Mr. C. H. Markham, of Chicago, Ill.

Mr. Thomas H. Pindell, former Superintendent of the Chicago, Peoria & St. Louis R.R., at Springfield, Ill., has been appointed Superintendent of the Alton & Southern Ry., at East St. Louis, Ill.

Mr. J. S. McBride, of Salem, Ill., Assistant Engineer of the Chicago & Eastern Illinois R.R., has been promoted to be Engineer in charge of valuation of the same railway with headquarters at Chicago, Ill.

Mr. H. O. Halsted, Superintendent of the Petoskey division of the Pere Marquette R.R., at Grand Rapids, Mich., has been appointed assistant to the General Manager, with headquarters at Detroit, Mich.

Mr. W. A. Townsend, recently Manager of the El Paso, Tex., office of the Ingersoll-Rand Co., has been made Manager of a new Los Angeles, Calif., office. Mr. Townsend is succeeded at El Paso by Mr. J. D. Foster.

Mr. C. A. Burnette, Assoc. M. Am. Soc. C. E., Consulting Engineer, of Spokane, Wash., has been appointed Contracting Engineer of the Illinois Steel Bridge Co., in Washington, Oregon, Idaho and part of Montana, with office at Spokane, Wash.

Mr. Ellis C. Soper, Assoc. M. Am. Soc. C. E., has been appointed Resident Engineer of the New Market St. bridge, Chattanooga, Tenn., of which Mr. B. H. Davis, Assoc. M. Am. Soc. C. E., is Chief Engineer, as noted on p. 813 of issue of last week.

Mr. A. E. Hess, M. Am. Soc. C. E., of Williamsport, Penn., has been appointed Assistant Field Engineer, Eastern district, Division of Valuation, Interstate Commerce Commission, in charge of the field party now engaged in a survey of the Norfolk Southern Ry.

Mr. D. F. Foust, of Clarksville, Tenn., has been appointed Engineer and Superintendent of Construction for the Montgomery County Road Commissioners. He will have charge of road construction for which $100,000 has recently been raised by a bond issue.

Mr. C. S. Kirkpatrick, recently Chief Engineer of the Cape Girardeau Northern Ry., Cape Girardeau, Mo., has been appointed Division Engineer of the St. Louis, Brownsville & Mexico Ry., with headquarters at Kingsville, Tex., succeeding Mr. E. S. Heyser, resigned.

Mr. Walter A. Johnson, of Atlanta, Ga., has been appointed Pneumatic Tool Manager of the Pittsburgh branch of the Ingersoll-Rand Co. Mr. C. F. Overly, of Pittsburgh, Penn., has been appointed to the same position at the Cleveland, Ohio, branch of the company.

Mr. Sidney Diamant, a graduate of Columbia University, class of 1902, has opened an office as Consulting Engineer at 15 East 40th St., New York City. Since his graduation Mr. Diamant has been engaged in the design and erection of timber, steel and reinforced-concrete structures.

Mr. Walter G. Kirkpatrick, M. Am. Soc. C. E., recently City Engineer of Birmingham, Ala., is now Engineer of the Northern division of the Alabama Power Co., at Birmingham. Mr. Kirkpatrick went to Birmingham in 1912 from Jackson, Miss., where he had been engaged in private practice, specializing in municipal work.

Mr. Rudolph P. Miller, M. Am. Soc. C. E., has resigned as Superintendent of Buildings, Borough of Manhattan, New York City, in order to assist the Building Committee of the Board of Aldermen in a revision of the building code for the city. Mr. Miller has previously been a member of several advisory commissions on drafting a new building code for New York City.

Mr. P. W. Pinkerton, of the firm of Foster & Pinkerton, Civil Engineers, of Montrose, Colo., has been made City Manager of Montrose by the city council. Mr. Pinkerton has been in contract and engineering work for several years, serving for a time as Deputy City Engineer of Montrose, Chief Engineer of the Grand View Mesa Irrigation Co., and as Chief Engineer of the Meyer Bros.' Construction Co.

Mr. Quincy A. Hall, formerly Engineer of Tests of the Isthmian Canal Commission, has become associated with the Morgan T. Jones Co., Inspecting and Supervising Engineers, Chicago, Ill., as Secretary and Engineer of Tests. Mr. Hall is a graduate in mechanical engineering of the University of Illinois. He recently resigned his position with the Isthmian Canal Commission after over six years' service.

Mr. E. G. Lane, Assoc. M. Am. Soc. C. E., for the past two years Assistant Engineer of the operating staff of the Baltimore & Ohio R.R., at Baltimore, Md., has been appointed District Engineer of Maintenance-of-way of the Baltimore & Ohio Southwestern R.R., with headquarters at Cincinnati, Ohio. Mr. Lane was formerly Division Engineer of the Baltimore & Ohio R.R. at Newcastle, Penn., and later Division Engineer of Maintenance-of-way at Pittsburgh, Penn.

Mr. George C. Scales, former Superintendent for the Barber Asphalt Paving Co., New York City, and for the past few years engaged in road construction in the South, has been appointed Senior Highway Engineer, U. S. Office of Public Roads, and will have charge of the southern end of the Washington-Atlanta experimental road, noted on another page of this issue. Mr. Scales attended the Massachusetts Institute of Technology from 1885 to 1889. For a time he was in engineering work in Porto Rico.

The Central R.R. of New Jersey announces the appointments of the following committees to coöperate with the Division of Valuation of the Interstate Commerce Commission in the valuation of the company's property:

An advisory committee is appointed consisting of Messrs. W. G. Besler, Vice-President and General Manager; Jackson E. Reynolds, General Attorney, and Jos. O. Osgood, M. Am. Soc. C. E., Chief Engineer. The valuation committee is: Messrs. Charles Hansel, M. Am. Soc. C. E., Consulting Engineer, New York City, Consulting Valuation Engineer, Chairman; Carl Tombo, Assoc. M. Am. Soc. C. E., Principal Assistant Valuation Enginer; E. Y. Allen, Assoc. M. Am. Soc. C. E., Assistant Valuation Engineer; Herbert Forsyth, Assistant Valuation Engineer; J. H. Moore, Assistant Real Estate and Tax Agent; George Holmes, Assistant Counsel; J. A. Taylor, Comptroller.

Mr. Joseph A. LePrince has resigned as Chief Sanitary Inspector of the Panama Canal and sailed for New York City Apr. 2. Mr. LePrince was appointed to the Panama Canal service in June, 1904. He was charged with the work of mosquito extermination, and, during the yellow-fever campaign in 1905, he served as Acting Health Officer of Panama, in addition to performing the duties of Chief Sanitary Inspector. He was engaged in mosquito work during his entire period of service. Mr. LePrince was born in Leeds, England, in 1875, but his parents removed to New York City when he was seven years old. He received his earlier education at Sach's Collegiate Institute, New York City, and subsequently entered the College of Mines of Columbia University. He was graduated in 1898, with the degree of C. E., and in 1899 took a post-graduate course, receiving the degree of M. A. During the cleaning up of Havana, after Spanish-American War, he was Assistant Chief Sanitary Officer of the Department of Health.

Besides the appointments of officers for the operation and maintenance of the Panama Canal noted in these columns, Mar. 26, p. 707, the following subordinate officers have been appointed:

Lieut. George R. Goethals, Corps of Engineers, U. S. A., continues as Assistant Engineer of the Fortification Division; Mr. William G. Comber continues as Resident Engineer of the Dredging Division; Mr. George M. Wells, M. Am. Soc. C. E., continues as Resident Engineer of the Municipal Engineering; Mr. Edward Schildhauer, M. Am. Soc. C. E., continues as Electrical and Mechanical Engineer of the Division of Erection; Mr. Walter F. Beyer continues as Assistant Engineer of the Division of Lighthouse Construction; Lieut.-Col. Chas. F. Mason, U. S. A., is appointed Chief Health Officer, Health Department; Lieut. Frederick Mears, Assoc. M. Am. Soc. C. E., continues as Superintendent and Chief Engineer of the Panama R.R.

The Panama R.R. Co., under the jurisdiction of the President of the company, who is the Governor of the Panama Canal and head of the Department of Operation and Maintenance, will be operated practically as a division of the Department of Operation and Maintenance, but will still retain its entity as a corporation.

OBITUARY

Owen Ford, a former consulting engineer and at one time in the employ of the city of St. Louis, Mo., died at his home in Tacoma, Wash., Apr. 6.

Charles F. Smith, former Superintendent of the Montana division of the Oregon Short Line R.R., at Pocatello, Idaho, died Mar. 30, at Niagara Falls, N. Y. He had been on leave of absence since last November because of ill health.

Ralph Galbraith Brown, a former electrical engineer with the General Electric Co., Schenectady, N. Y., died recently from pneumonia at Nice, France. In recent years he had been a hotel proprietor on the north shore of Massachusetts.

Lemuel H. Davis, a pioneer gas engineer, died at his home in Philadelphia, Penn., Apr. 8, aged 91 years. He is said to have built the first gas works at Detroit, Mich., and subsequently erected numerous other gas plants throughout the country.

William O'Herrin, Assistant to the General Manager of the Missouri, Kansas & Texas Ry., at Dallas, Tex., died Apr. 2 in Chicago, Ill., from injuries received near Sedalia, Mo., in 1908, when he fell from a bridge pier while directing the work of rescuing passengers from a wrecked train.

John McNamee, a prominent New York City contractor, died at his home in Brooklyn, N. Y., Apr. 7. He was born in Brooklyn, N. Y., 72 years ago. For a time he was with the city engineering department of Brooklyn. Later he entered the contracting business and constructed important public-works both in New York City and throughout the East. In 1903 he was associated with F. L. Cranford under the firm name of Cranford & McNamee, which firm constructed parts of the first subway in Brooklyn and the Centre St. subway in Manhattan. Mr. McNamee retired from active business in 1909.

ENGINEERING SOCIETIES

COMING MEETINGS

SOUTHERN GAS ASSOCIATION.
Apr. 22-24. Sixth annual meeting at Mobile, Ala. Secy., E. D. Brewer, 45 Poplar Circle, Atlanta, Ga.

NATIONAL DRAINAGE CONGRESS.
Apr. 22-25. Annual meeting at Savannah, Ga. Secy., J. R. Gray, Chamber of Commerce, Savannah, Ga.

IOWA STREET AND INTERURBAN RAILWAY ASSOCIATION.
Apr. 22-25. Annual meeting at Waterloo, Iowa. Secy., H. E. Weeks, Tri-City Ry. & Light Cos., Davenport, Iowa.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 5-7. Annual meeting in Chicago, Ill. Secy., Franklin H. Wentworth, 87 Milk St., Boston, Mass.

AIR BRAKE ASSOCIATION.
May 5-8. Convention at Detroit, Mich. Secy., F. M. Nelis, 53 State St., Boston, Mass.

AMERICAN WATER-WORKS ASSOCIATION.
May 11-15. 34th Convention at Philadelphia, Penn. Secy., J. M. Diven, 47 State St., Troy, N. Y.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 18-21. 6th convention in Chicago, Ill. Secy., C. G. Hall, C. & E. I. R.R., 922 McCormick Bldg., Chicago, Ill.

SOUTHWESTERN ELECTRICAL AND GAS ASSOCIATION.
May 20-23. Annual meeting at Galveston, Tex. Secy., H. S. Cooper, 405 Slaughter Building, Dallas, Tex.

SIXTH NATIONAL CONFERENCE ON CITY PLANNING.
May 25-27. Toronto, Ont. Secy., Flavel Shurtleff, 19 Congress St., Boston, Mass.

MASTER BOILER MAKERS' ASSOCIATION.
May 25-28. Convention at Philadelphia, Penn. Secy., H. D Vought, 95 Liberty St., New York City.

NATIONAL DISTRICT HEATING ASSOCIATION.
May 26-29. Sixth convention at Rochester, N. Y. Secy., D. L. Gaskill, Greenville, Ohio.

Philadelphia Association of Members of the American Society of Civil Engineers—The first meeting of the Association was held in the Engineers' Club, Philadelphia, on Apr. 6. Frederick T. Stearns, past president Am. Soc. C. E. and chairman of the committee of that society on Valuation of Public Utilities addressed the meeting on that subject. The next meeting will be held in October. The Secretary is W. L. Stephenson, 412 City Hall, Philadelphia, Penn.

Southern California Association of Members of the American Society of Civil Engineers—Following a dinner at the University Club, Los Angeles, Calif., on Apr. 8, Dr. Carpenter, of the U. S. Weather Bureau, read a paper on the recent heavy rains in southern California, which caused heavy floods. The greatest damage was caused by the two-hour rain on Feb. 18. The rainfall during that time was as follows: 5 min., 0.36 in.; 10 min., 0.66 in.; 1 hr., 1.12 in. He stated that the ratio between the rates of rainfall at Los Angeles and on higher altitudes in the vicinity was constant during different portions of the storm. The serious damage was largely the result of soil soaked by previous heavy rains. The saturation of the soil and the hardening of its surface during the interval between storms caused a percentage of run-off considerably above that of average years.

The Association discussed the starting of a movement among engineers and members to induce Congress to appropriate more money for the study of rainfall and run-off, and to educate the general public in regard to the importance of such information. It was suggested that further study of the rainfall in the mountains is desirable, particularly as to snow conditions; and as far as possible, the volume and water content of snow remaining in the mountains after storms. This would give an idea of what might be expected when these snows were melted in the spring or summer months. It was suggested that the coöperation of the forestry service might be valuable in the way of furnishing observers. Dr. Carpenter stated that the Bureau of Forestry had offered to take care of a considerable number of rain gages in the mountains, provided such gages were furnished. A committee was then appointed, to consider what could be done toward providing funds for furnishing the gages.

A committee was appointed also to confer with the City Council regarding proposed changes in the Building Code of the city. The Secretary of the Association is W. K. Barnard, Los Angeles, Calif.

National District Heating Association—In the program of the sixth annual convention to be held in Rochester, N. Y., May 26-29, the following subjects will be discussed: "Expense of Operating Centrifugal vs. Double-Acting Pumps"; "Effect of Super-Heated Steam on Heating Systems"; "Heat Losses from Buildings of Latest Construction"; "Commercial Steam Heating in New York City." The Secretary is D. L. Gaskill, Greenville, Ohio.

Train Dispatchers Association of America—The next convention will be held at Jacksonville, Fla., June 16-19. The Secretary is John M. Mackie, 7122 Stewart Ave., Chicago, Ill.

International Engineering Congress—Enrollments in, and subscriptions to, the Congress to be held in San Francisco in 1915, have been received from citizens of 42 foreign countries. The foreign enrollment represents 25% of the total enrollment. The number of subscriptions from the members of the five national engineering societies of the United States, under whose auspices and control the Congress is being held, is 3.7% of the total. Full information concerning the Congress may be obtained by addressing the Committee of Management, Foxcroft Bldg., San Francisco, Calif.

Association of Railway Electrical Engineers—The semi-annual convention will be held in Atlantic City, N. J., on June 12, with headquarters at the Hotel Denis. The annual convention will be held at Chicago, Ill., Oct. 19-23. The Secretary is Joseph A. Andreucetti, Room 411 C. & N. W. Terminal Station, Chicago, Ill.

American Institute of Consulting Engineers—A dinner meeting was held Apr. 13, at the City Club, New York City. The subjects discussed were "the conduct of engineering competitions" and the "interference by the contractor with the practice of the consulting engineer." The President of the American Institute of Architects and two other members were present to give an account of the rules and regulations of the Institute governing the conduct of architectural competitions. These rules have been reduced to the simplest possible form and contain only three essential elements. (1) Experts must have charge of such competitions; (2) Experts must be judges in such competitions; (3) No man must be allowed to compete, who would not be qualified and competent to carry out the work if the award is made to him. From the remarks of the architects it is judged that even this institution, which has a good many years' start, has not yet reached smooth waters. It was generally agreed by all present that the problem of the engineer was more difficult, more complex, and farther from being solved than was the case of the architects some years ago. Various phases of the consulting engineer's troubles were discussed by Gustav Lindenthal, Ralph D. Mershon, John F. Wallace, George Gibbs, Frederic Molitor, Ralph Modjeski, Philip W. Henry and others. Mr. Lindenthal thought the first step was to follow the first step made by the American Institute of Architects and educate engineers to an appreciation that it was for their own interest not to compete unless assured of fair play. A motion was made by John F. Wallace, and was subsequently passed, to have the matter referred to the Institute's committee on ethics, which is to draw up a code to govern the participation of engineers in furnishing competitive designs for engineering structures. The competition of the large contracting and manufacturing firms was admitted a more serious phase of the problem and few suggestions were made for the remedying of it.

Engineering Literature

CONTENTS

	Page
REVIEWS AND NOTES:	
Railroad Curves and Earthwork—Textbook on Railroad Surveying. Reviewed by F. Lavis	871
"Machinery's" Handbook. Reviewed by Rossiter R. Potter	872
Mississippi River Flood Problem	873
Ventilation and Humidity. Reviewed by D. D. Kimball	873
Farm Motors	873
Electro-Thermal Methods of Iron and Steel Production. Reviewed by J. W. Richards	874
The Efficient Man	874
The Theory of Heat Engines. Reviewed by Lionel S. Marks	874
Thermodynamische Grundlagen der Kolben- und Turbokompressoren. Reviewed by Winslow Herschel	874
Gear Cutting in Theory and Practice. Reviewed by Ralph E. Flanders	875
A Textbook of Pure Mechanism. Reviewed by John J. Flather	875
Details of Cyanide Practice. Reviewed by F. W. Traphagen	875
Der Entwurf der Kanalisation für Naunhof Bei Leipzig. Reviewed by Emil Kuichling	876
The Maintenance of Foreshores	876
Studies in Water Supply. Reviewed by Geo. W. Fuller	877
PUBLICATIONS RECEIVED	877

The newest thing in the efficiency line which has come to the attention of the editors of this journal is *"insulting* efficiency." As yet only the low figure of 80% efficiency has been reached, but when the real efficiency experts get to work this limit will doubtless be greatly exceeded, since the new form of efficiency originated with a mere tyro who was conducting linotype experiments with the word "insulating."

REVIEWS AND NOTES

Railroad Surveying

Reviewed by F. LAVIS*

RAILROAD CURVES AND EARTHWORK—By C. Frank Allen, M. Am. Soc. C. E., Professor of Railroad Engineering, Massachusetts Institute of Technology. Fifth edition, revised. [Also in same volume, "Field and Office Tables" by same author. Revised edition.] New York and London: McGraw-Hill Book Co., Inc. Leather; 4x7 in.; pp. xi + 226 and v + 282; illustrated. $3, net; or separately, $2 each.

TEXT BOOK ON RAILROAD SURVEYING—By George Wellington Pickels, Instructor, and Carroll Carson Wiley, Associate, in Civil Engineering, University of Illinois. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Flexible leather; 4x7 in.; pp. ix + 263; 66 text figures; 14 tables. $2.50 (10½ shillings), net.

It can be said at once that Prof. Allen's book, on account of the tables and other information it contains, is a useful one for any engineer to have who is engaged in field work, or surveys, for the location or construction of railways. It is entirely practical from beginning to end and contains, so far as the writer can judge, all or nearly all that is usually required in the field and office for this class of work.

The book is based on material used by the author for his classes at the Massachusetts Institute of Technology, the first edition having been published in 1899. As this is the fifth edition, it may be expected that its present form is the result of mature thought after considerable experience in actual use in his classes, and such an examination of the book as the writer has been able to make convinces him that not only is the information good, but that the result justifies the expectation in regard to its arrangement and presentation, and also of its usefulness in the field.

It may be noted that the title of this book is simply "Railroad Curves and Earthwork, with Tables." It is not claimed that it is a textbook or field book, though with certain limitations it may serve as either much better than some with more ambitious titles. It may be divided roughly into four parts, as follows:

	Pages
(1) A brief general description of location surveys	30
(2) Curve problems, turnouts, spirals	117
(3) Earthwork, staking out, computation, haul	81
(4) Tables	281

The description of the methods used on surveys for railroad location, though brief, is generally accurate and quite to the point. It is sufficient to indicate in general outline the work to be done and the method of doing it. The writer does not agree with the author's advocacy of the use of the aneroid barometer and certain other pocket instruments for reconnaissance, as he believes that, with certain minor exceptions, when anything more than the eye of the engineer making the reconnaissance is required, a rough rapid stadia survey is the only practical means of filling the requirement. It must be admitted, however, that this is a matter on which there is considerable difference of opinion.

The statement of the purpose of the Preliminary Survey is so nearly in accord with that which has been advocated by the writer, and which so far as he knows is the only definition of similar tenor, that its essential feature is worth noticing, and that is the idea that the Preliminary is essentially a survey which shall serve as a base for location and to collect data from which this latter may be determined.

The writer has previously expressed his opinion as to the doubtful utility of including geometrical problems, even though they relate to curves, in a field book for engineers, the book under review, however, seems to have reduced this apparently necessary infliction to a minimum and the presentation is clear. This is especially true of the chapter on turnouts. The spiral described is that advocated by the American Railway Engineering Association, as are also the spiral tables given at the end.

The author devotes one page to a good description of "Metric Curves." He states that there are two distinct systems of nomenclature as follows:

I. The Degree of Curve is the angle at the center subtended by a chord of 1 chain of 20 meters.

II. The Degree of Curve is the deflection angle for a chord of 1 chain of 20 meters (or one-half the angle at the center.)

III. Or, very closely, the Degree of Curve is the angle at the center subtended by a chord of 10 meters (equal to 1 station length.)

He favors the latter, and as practice has not crystallized in this matter he cannot be greatly criticised. The experience of the writer, however, inclines him to think that the first is in more general use. There seems to be no good reason for the introduction of the word chain in this connection. In southern South America, where European practice prevails, curves are usually designated by even lengths of radius, which, as the author observes, has many disadvantages and little if any advantage. It is hoped that some day some one will calculate some spiral tables based on the A. R. E. A. spiral for metric curves. It is to be noted also that the metric tables are given only for each 10 minutes, which with the short chord length adopted is equivalent to each 30 minutes for the ordinary North American nomenclature. Tables for every 2 min. for 20-m. chord curves have been calculated and are easily available, it is, therefore rather to be regretted that a little more space was not devoted to these tables if it is thought worth while to include them at all. It is noted also that the metric system curves are designated in the table by the Index of the Deflection Angles for 20-m. chords. There is no reason, of course, why they should not be designated exactly as are our own by the degree subtended at the center by whatever length of chord is decided on as standard, and it is to be regretted that anything is introduced varying from United States standard practice except that made necessary by the actual difference in units of measurement.

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The chapters on earthwork are unusually good. The reviewer knows of no other place, with possibly one exception, where such full and complete information on this subject is to be found or where it is so well presented. Of course, the method of setting slope stakes will look more or less complicated to a "roughneck" who knows little more than how to add or subtract, yet gets in a mile or so a day, but this is probably unavoidable when one tries to reduce to writing what some of us learned to do by instinct. The chapters on Earthwork Diagrams, Haul, and the use of the Mass Diagram are very good and useful.

The tables are generally quite complete so far as they go, well arranged, and easy to use. The writer believes, however, that there is need of a field book with much more detailed tables, and this part of the book might well be enlarged at the expense of the geometrical examples. It would not be as useful to students, but would be vastly more so as a practical field book.

The book by Pickels and Wiley attempts to cover the same ground as the one just reviewed but contains only about half as many pages of the same size, though its title is "Text Book on Railroad Surveying."

The first 23 pages are devoted to a description of Location Surveys, Organization of Field Parties, Maps, and an attempted explanation of the value or importance of Distance, Curvature and Grades. This part is somewhat sketchy and shows a certain lack of care and clearness of expression. For instance, the statement is made that:

In the location of a railroad there are three factors that make for success or failure from a financial standpoint; namely, distance, curvature and grades.

Now it is perfectly evident to an experienced railroad engineer what may be meant—but it is generally thought that the amount and character of traffic, competition or its lack, and factors of that nature are most important from a financial standpoint.

The statement is made without qualification, that:

Curve resistance does not vary directly as the degree of curve, but decreases (proportionately) as the degree of curve increases.

The writer is inclined to believe that this is true but he doubts if there is anything that warrants the unqualified statement. There is a statement that:

The cost of construction is increased (by curvature) since curvature means an increase in the length of the line.

This, of course is very bad. The frictional resistances of freight trains, it is stated, "remain practically constant at 8 lb. per ton, while the grade resistance is 20 lb. per ton for each per cent. of grade. The length of such a grade (?) is limited only by the endurance of the engine." There is no reference to the fact that with some types of modern freight equipment the frictional resistance may be as low as 3 or 4 lb. per ton; "each per cent." is surely not very clear, and the last sentence of the quotation is wholly unintelligible.

The chapters on curves have been written with an evident attempt to make them clear to students or others with the most elementary knowledge of the subject, though some geometrical knowledge is presupposed. The instrumental operations of staking out curves under various conditions are described in some detail, and there are a series of questions and answers following the explanation of each problem From the point of view of the reviewer it would seem to be rather more advisable to train students to understand principles than to explain processes.

The chapter on curves is divided into two parts, circular curves and spirals, and is followed by a chapter on Earthwork, in which latter the curious expression "growth" is used instead of "swell." There is a chapter on Turnouts, Crossings, Connections, etc., and Tables of Radii, Functions of a one-degree curve, Logarithms, Natural Sines, etc. and Earthwork quantities.

The statement is made in the preface that the book was written primarily for the use of students, but it is believed (by the authors) that it will appeal to the practicing engineer as well. This latter belief the writer thinks is not well founded, as many useful tables have been omitted and the endeavor to cut down the size of the book has resulted in a sketchiness of treatment which leaves much to be derived. The text contains much that is elementary and which should be of value only to students.

Field books of the type of Henck, Searles, Webb or Allen are useful to the engineer in the field. During the past few years, however, there seems to have been an attempt on the part of the instructors or professors of engineering schools and colleges, for each to get out his own individual "Text" book or "Field" book on Railroad Surveying. This seems to the writer to be a great waste of energy as they contain nothing new and are mostly inferior to either of those mentioned, even though the first two are practically out of date.

Another Machine Handbook

Reviewed by ROSSITER R. POTTER*

MACHINERY'S HANDBOOK for Machine Shop and Drafting-Room: A Reference Book on Machine Design and Shop Practice for the Mechanical Engineer, Draftsman, Toolmaker and Machinist. New York: The Industrial Press. Leather (flexible); 5x7 in.; pp. 1400; illustrated. $5.

The field covered by this handbook corresponds closely with that of the periodical from which it takes its name. The information collected here is calculated to be of interest to those engaged in the operation, construction or design of machinery. Steam and electrical engineering are not touched upon, except for a paragraph on the power rating of steam hammers in the section on forge-shop equipment, a couple of pages on electric welding and some twenty pages on electric motors used to drive machine tools. A dozen pages each are devoted to foundry and forge-shop practice, but the "practical" portions of the book deal chiefly with machine-shop work.

The arrangement of this book differs from that of many other handbooks in that there is no broad classification into a dozen or so principal sections, each including a number of more or less related subdivisions. Related subjects are here grouped together, to be sure, but there is nothing in the way the book is printed to show this. However, this may not greatly affect the book's value.

Conventional handbook design is followed in opening with mathematical tables and formulas. Arithmetic, algebra, geometry, logarithms and trigonometry are included but the book stops short of analytical geometry and calculus. A chapter on mechanics and one on strength of materials completes the introductory or general portion of the book. This portion occupies the first 369 pages, which will convey some idea of the detailed nature of the mathematical tables. There are a number of tables not ordinarily found in technical handbooks; for instance, a table giving the length of chords for spacing the circumferences of circles into any number of equal parts up to 100. Another example is a table of prime numbers and factors giving the smallest odd factor of all prime numbers from 1 to 9999. There are five pages of instructions on the use of logarithms, with illustrations showing graphically how to read the tables. The logarithm tables themselves give five-place logs. and are well arranged without cramping. A full table of hyperbolic logarithms is given.

One of the very few typographical errors discovered by the reviewer occurs in this first portion of the book, in the chapter on Mechanics. On page 274 of this chapter, parentheses are omitted from formulas where they are really needed to avoid ambiguity. Another point for criticism in this chapter is the omission of all reference to air resistance in the section on projectiles. Moreover, on page 277 in an example on energy of falling bodies, a projectile fired "vertically" from the muzzle of the 12-in. gun "strikes the ground" when it comes down. Persons of a precise turn of thought may be perplexed by this.

It would be out of the question to discuss in detail each one of the seventy odd sections which make up the balance of the book. Immediately after the mathematical portion come sections on riveting and riveted joints; strength and properties of steel wire and wire rope; formulas and tables for spring design; shafting and torsional strength. Next comes a more or less related group on friction; plain, roller and ball bearings; keys and keyways; clutches and couplings; and friction brakes.

In the section on bearings, the data on ball and roller bearings are mixed together in a way not altogether desirable. Pages 486 and 487 should be interchanged to give a better arrangement of the subject matter. It looks as though the exigencies of "make-up" in the printing shop had been allowed to interfere at this point with the more important matter of logical sequence of text and tables. The omission from this section of any reference to the Hyatt type of roller bearings with rollers of spiral steel must surely have been an oversight.

The section on keys and keyways includes information on square and splined shafts for fixed and sliding fits. On page 504 is a table of dimensions for square shaft ends for permanent and sliding fits which appears to be identical with the table of standards adopted by the Society of Automobile Engineers and published in the S. A. E. handbook, although no mention is made of this point. Apart from the ethical question involved, some reference to this fact would increase the value of the table for the users of this volume. In the section on clutches and couplings, there is no mention of the friction-disk type of clutch which is used extensively on

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*Assistant Manager and Production Engineer, Blood Bros. Machine Works, Kalamazoo. Mich.

automobiles, and the statement in a paragraph on automobile clutches that the "cone clutch is generally considered the best type for automobile transmission" is a bit to sweeping to pass unchallenged. Another criticism of this section falls on the paragraph on universal joints, where the statement of conditions for absolute uniformity of motion of the driven shaft is not complete.

The next group of sections, or chapters, covers spur and bevel gearing and other means of power transmission. This includes sections on cam design and cam milling, spur gearing, bevel gearing, worm gearing, spiral and herringbone gearing, belts and pulleys, rope transmission, chain drives, worm and spiral gearing occupy over 150 pages and the information given is notably complete and to the point. In the section on bevel gearing, for example, there is a table of exact face angles (to the nearest minute) for all combinations of pinions from 12 up to 38 teeth with gears from 13 up to 72 teeth. Corresponding tables cover the other angles involved in bevel gear design. The data on gearing are fuller and presented in more usable form than in books devoted to this subject alone.

Next comes a group of sections presenting information bearing chiefly on details of shop practice. The topics are screws, handles, handwheels and other machine details; speeds and feeds for machine tools; automatic screw-machine practice; tapping and threading; lubricants for machine operations; running; shrinkage- and forced-fit allowances; measuring instruments and gaging methods; change gears for spiral milling; milling machine indexing; and jigs and fixtures. Immediately following this is a group of sections chiefly on tools, giving dimensions, uses, etc., of broaches, taps, milling cutters, reamers and other small tools. This group includes a section on grinding and grinding wheels and one on punches, dies and press work. As an example of the exhaustive nature of the practical data presented may be mentioned a series of tables in the section on milling cutters. These tables give the angles to which the dividing head of the milling machine must be set for milling angular cutters of all angles (at 5° intervals) up to 85°. These tables alone occupy ten pages.

A group of sections dealing chiefly with metallurgical subjects is next in order. Among the subjects touched upon are foundry and forge-shop practice, oxyacetylene and electric welding, heat treatment of steel, etc. The section on the heat treatment of steel is particularly full, occupying nearly 40 pages. It includes tabulated information on cutting off, annealing and hardening twelve commonly used brands of high-speed tool steel, and a table on heat treatment and properties of carbon and special alloy steels of different analysis. This latter table is taken from the S. A. E. handbook, suitable credit being given in this case.

After this come the twenty odd pages on electrical machinery, including data on the horsepower required for different machine tools and forging machinery. Finally there are a dozen sections on miscellaneous subjects, such as properties and weights of materials, compressed air, pipe and pipe fittings, and the appraisal of manufacturing plants. There are nearly 30 pages of tables of weights and measures, of which 18 or 20 pages are devoted to metric conversion tables. In the section on plant appraisal, there is an apparent discrepancy on page 1366 where the estimated life of belting is given as ten years, whereas the depreciation to be deducted annually from the initial cost is given as 40%.

For the first edition of a volume of nearly 1400 pages, this book appears to be surprisingly free from typographical and other errors. One of the commendable features is that it sticks pretty closely to the presentation of facts, giving little space to mere opinion or speculation over doubtful matters. The material is, in general, well selected and presented in a way which makes it easily available. Perhaps the most noticeable characteristic of the book is the emulation of the German tendency to not only state a formula but also present a table of numerical solutions covering all ordinary cases. After giving fair notice that he has not yet examined Mr. Halsey's latest production [see "Eng. News," Jan. 15, 1914—Ed.] the reviewer feels free to state that this is by far the best handbook he has ever seen for the machine designer, detailer or draftsman.

MISSISSIPPI RIVER FLOOD PROBLEM; How the Floods Can Be Prevented—By John A. Fox. Prepared and presented by the Mississippi River Levee Association, Scimitar Building, Memphis, Tenn. Flexible leather; 9x12 in.; pp. 63; splendidly illustrated.

This is a very handsomely gotten up monograph, compiled by the author for the Mississippi River Levee Association of Memphis, Tenn. The object of the Association is to induce Federal Government appropriations for the strengthening and completion of the Mississippi River levee system. The principal facts regarding Mississippi River floods are presented in a graphic manner by halftone views, and by statements selected from published articles written by leading engineers. While the book is prepared for Congressmen and the lay public rather than for engineers, it will interest many of the latter.

Factory Ventilation and Humidification

Reviewed by D. D. KIMBALL*

VENTILATION AND HUMIDITY in Textile Mills and Factories—By Cecil H. Lander, Lecturer in Civil Engineering, University of Manchester. New York and London: Longmans, Green & Co. Cloth; 5x8 in.; pp. viii+175; 54 text illustrations. $1.40, net.

For some years American engineers have been much interested in the agitation on the part of workers in English cotton mills, concerning temperatures and humidity in weaving sheds, which resulted in thorough investigation on the subject by a Royal Commission, and the promulgation of rules and orders covering several phases of health and safety in factories and workshops.

The author of the book before us has endeavored, with a large measure of success, to present the essential features of these regulations, the methods in general use to meet their requirements, and certain engineering data essential to an understanding of the problem.

The early chapters of the book deal with air purity, temperature, heat, humidity, evaporation, instruments and methods of measuring these, special atmospheric conditions required for handling different materials, methods and materials used in treating yarns, humidity used in working with various classes of goods, effect of different meteorological conditions, and the physiological effects of humidity and temperature.

The different methods of humidification in general practice are discussed and all of the commonly used systems are illustrated and described, including the best known American systems—which suffer nothing by comparison.

Temperature and humidity conditions required in textile factories and mills operated under different conditions are detailed at considerable length. Much consideration is given to the question of cooling, and reference is made to the efficiency of steam-pipe coverings as used in the mills. It is interesting to note that coverings for use in these mills must be approved by an appointed authority and have an insulating efficiency of not less than 80%.

The general features of mill construction are discussed, including orientation, position in relation to adjacent buildings, roof and floor constructions.

The appendix gives in full the admirable rules and orders governing the heating and humidification of factories and workshops, as now applied, a schedule of the permissible humidity, and forms in accordance with which records of humidity must be kept.

The book should be of real interest and value to the owner or operator of cotton-weaving sheds and similar factories or workshops and of general interest to the engineer, but it contains only a few engineering data which would guide the engineer in the design of a ventilating, humidifying or cooling system for a cotton-weaving shed or factory.

Farm Power

FARM MOTORS, Steam and Gas Engine Hydraulic and Electrical Motors, Windmills—By Andrey A. Potter, M. Am. Soc. M. E., Professor of Steam and Gas Engineering, Kansas State Agricultural College. [Agricultural Engineering Series.] New York and London: McGraw-Hill Book Co., Inc. Cloth; 5x8 in.; pp. ix + 261; 278 text illustrations. $1.50, net.

The first impressions of this book as it is taken in hand are not pleasing, chiefly on account of the air of cheapness which is given it by the large use of catalog cuts. A few of the illustrations are very good, judged from any standpoint, a few are atrocious, even not considering that they are antidiluvian trade cuts. Evidently this condition has arisen from making the book as low priced as possible and from putting it out quickly. It is a pity, however, that author and publisher could not have secured these ends otherwise and thereby turned out a book that would help cultivate the esthetic tastes of the student.

Fortunately on reading the book the first unfavorable impressions are modified, for the text seems to have been care-

*Of Richard D. Kimball Co., 15 West 38th St., New York City.

fully written; the ideas are conservatively stated and presented in a logical order.

As primary movers the author has taken up steam, gas, oil, water and wind-driven machines, with electric motors as secondary sources of power and with traction engines and automobiles as special applications of two important prime movers. This matter he generally arranges in the sequence of theory, construction and use.

As an introductory chapter, the oasic energy reactions in prime movers are epitomized. Then, covering some 10% of the book, there is a combination of applied physics and mechanical engineering, presenting topics like work, power, heat, fuels, combustion processes, steam production, etc. Some 25% is devoted to steam-plant practice and 20% to gas engines. Most of the steam equipment described is larger than would be expected for farm plants, though, of course, it may be well for the student to know about brick settings, water-tube boilers, feed-water heaters, induced-draft plants, mechanical stokers, Corliss engines and condensers . There is a question here as to whether it might not have been as well, if the author were going outside the real farm motors at all, to pay as much attention to the more modern steam turbine in types not apt to be found in agricultural service.

In taking up gas and oil engines, the author confines himself more strictly to small types in widespread farm service. Considering the presentation of steam engines, one may ask why the large-plant types and gas-producer stations have not been included. There are only a few pages on windmills, but there is no evident need for more. Under water motors there is a good little discussion of hydraulic theory, but an inadequate presentation of the practical side, considering the importance of farm water powers (except in the Middle West where the author teaches). In leading up to farm use of electric motors, etc., there is a review of rudimentary electrical theory; then a farm generating station is described, but only with gas-engine drive. There is a final chapter on mechanical transmission of power, describing belts, pulleys, gears, rope drives, shafting, etc.

From the foregoing notes it will be seen that the book will be of much use in any farm-power instruction course and of interest to any well educated agriculturist, though its use will involve additional lectures or reading best to meet the requirements in some parts of the country.

Electric Steel Furnaces

Reviewed by PROF. J. W. RICHARDS*

ELECTRO-THERMAL METHODS OF IRON AND STEEL PRODUCTION—By John B. C. Kershaw. With an Introduction by Dr. J. A. Fleming. New York: D. Van Nostrand Co. London: Constable & Co. Cloth; 6x9 in.; pp. xxiii+239; 92 illustrations. $3 (8½ shillings), net.

This is a good descriptive work, intended to give details of actual installations, methods of operation, summaries of tests of raw materials and finished products, and of working costs. The author wisely avoids attempting a scientific analysis of the reactions and operations, or giving theoretical discussion, except where stating the general scientific principles of electric heating and steel refining, in Chapter II—and there they are stated about as often wrong as right. Outside of the mistakes in Chapter II, however, the rest of the work describes clearly and interestingly the various furnaces now in operation, giving very practical information such as would be needed by the steelmaker who was considering installing an electric furnace. A minor blemish is carelessness in proper names, e.g., Nürnburg for Nürnberg; Tacomy and even Tacoma for Tacony; Quesnau for Queneau. The paper and type are good, pictures fine and the book full of valuable information.

THE EFFICIENT MAN; For the use of all interested in the training of minors and development of supervisors to best manage men and work in commerce, manufacture, transportation and engineering, to decrease cost of production and living, and prepare man to best prolong his young-old years of servient labor and proficiency—By Thomas D. West, M. Am. Soc. M. E. Cleveland, Ohio: T. A. Gerblick, Sales Manager, 10,511 Pasadena Ave. Cloth; 5x8 in.; pp. 330; 28 illustrations. $1.50, postpaid.

Some idea of the viewpoint of the author may be given by noting that in the first paragraph of his introduction he speaks of the "growing inefficiency of man" and that in the next paragraph he attributes this condition to "the recent universal craze to escape work." Further along the author urges that true efficiency means a greater and better output for less money, with at least equal safety to life and property, and under at least as pleasant conditions for the workers.

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The book differs from others on efficiency. It [illegible] not appeal to all, especially at a glance; but careful [illegible]ng will awaken interest in some of the thoughtful. It[illegible] is well illustrated in the chapter on the "Touch[illegible] [illegible]anness assed by officious employers and irritated by wi[illegible]cal employees in the form of "crabbed cranks" and "gr[illegible] granies." A biographical sketch of the author is g[illegible] which allows the reader to judge of his fitness to [illegible]ss this subject.

Heat Engine Theory

Reviewed by LIONEL S. MARKS*

THE THEORY OF HEAT ENGINES—By William Inchley, Lecturer in Engineering in University College, Nottingham. New York and London: Longmans, Green & Co. Cloth; 6x9 in.; pp. xii + 492; 246 text illustrations. $2.25, net.

There are already in existence several excellent books on heat engines by English authors, notably those by Ewing and Ripper. A new book covering approximately the same field must necessarily be judged by comparison with its precursors. The present author announces that his book has been written mainly for engineering students, and, furthermore, that he feels no apology is necessary for adding another book on this subject, because although many excellent books exist which deal solely with one or two special branches of the subject, there are very few which deal with the subject as a whole.

An examination of the book does not wholly confirm the author's justification of its existence, but it does bring out many other reasons why the appearance of this book is to be welcomed. The most important of these is the greater thoroughness with which many of the topics are treated. The treatment is almost exclusively mathematical with very little descriptive matter. The range covered is that which is customary in books on technical thermodynamics, with the addition of chapters on valve diagrams, dynamics of reciprocating engines, balancing and governing. While the book makes no important contributions to the theory of heat engines, it nevertheless brings together, for the first time, the results of a number of recent contributions, particularly by English investigators, and makes them more available. It is in this respect, in particular, that it should prove most useful to American students and engineers.

The rate of dissemination of engineering information between England and America is surprisingly slow in view of the existing possibilities. The excerpts from the papers presented to the British Institution of Mechanical Engineers or to the Institution of Civil Engineers, and from the Reports of the Gaseous Explosions Committee of the British Association which are embodied in the book, are but little known here. Conversely, the author seems to be but little acquainted with recent work in this country; his book could have been enriched in a number of places by the addition of data obtained from this side of the water.

It is not easy to single out any special portion of the book as notably better than others. The treatment as a whole is well balanced. It ought to prove a very satisfactory textbook in those technical schools where mathematical methods are not shirked.

Thermodynamic Diagrams

Reviewed by WINSLOW HERSCHEL†

THERMODYNAMISCHE GRUNDLAGEN DER KOLBEN-UND TURBOKOMPRESSOREN; Graphische Darstellungen für die Berechnung und Untersuchung—Von Adolf Hinz, Oberingenieur der Frankfurter Maschinenbau - Aktien-Gesellschaft vormals Pokorny & Wittekind in Frankfurt a. M. Berlin: Julius Springer. Cloth; 9x12 in.; pp. vii + 58; 54 text figures; 38 calculation tables. 12 Marks.

Exponential equations are a bane alike to the student and to the practising engineer, and any book like "Thermodynamische Grundlagen," which offers help in their solution, is most welcome.

The text, which serves as an introduction to the diagrams, gives the derivation of the fundamental equations of thermodynamics with tables of the properties of gases, final volume in adiabatic and polytropic expansion and data for the construction of polytropic curves, while the last 15 pages are devoted to the flow through nozzles.

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The 38 full-page diagrams which follow are clear and well printed in green and black, and are designed to save the reader from laborious and time-consuming calculations. Only the first diagram, which is used to convert height of mercury column into pressure, shows a linear relation, all the others being more complicated and not readily calculated by the slide rule. By the use of several sheets for the more important subjects, the advantages of a large scale, with the degree of accuracy obtainable with an ordinary-sized slide rule, are attained without an inconveniently large book.

Twenty of the diagrams refer to the work required under various conditions of adiabatic, isothermal and polytropic compression. Other subjects are: Relation between elevation and atmospheric pressure; specific volume of air; calculation of humidity; values of the gas constant R; volumetric efficiency with adiabatic expansion; and entropy table for air. It will be seen from the above list that the field of the book, though not extensive, is well covered. The index is well arranged so that the reader does not, as is so often the case, have difficulty in finding the text which explains the diagram in which he is interested.

Gear Cutting

Reviewed by RALPH E. FLANDERS*

GEAR CUTTING IN THEORY AND PRACTICE—By Joseph G. Horner, A. M. I. Mech. E. [The "Mechanical World" Series.] Manchester and London: Emmott & Co., Ltd. Cloth; 6x9 in.; pp. xii + 391; 367 illustrations. 7½ shillings, net.

This excellent book holds within its covers almost as much general information on the subject of gears and gear cutting as can be packed into four hundred odd pages of type and illustrations. Its somewhat loosely arranged chapters cover the elements of tooth action and tooth design, principles of tooth cutting, machines embodying those principles and practical information on the operation of the machines. The amount and variety of the instruction given demonstrate anew the fact that even so small a subdivision of the engineering field as this may be made the subject of long study without exhausting its possibilities.

The author lays himself open to some minor criticisms which do not affect the usefulness of the book as a whole. His worst fault, perhaps, is the inexactness of his terminology. Like all the rest of us, he stumbles on the "spiral gear" whose teeth are not "spiral" at all, but helical. He says: "The spiral gears—one of the great group to which the helical and worm types are related," etc. As a matter of fact the so called "spiral gear" is a modification of the spur in which the pitch cylinder degenerates into pitch circles, and the line contact into point contact. His "helical gear" is a true spur gear with true spur gear action—the fact that the teeth are twisted does not affect the theory in any way; while worm gearing resolves itself into rack-and-pinion action. So when the author remarks later "There is no hard and fast division between spiral and worm gears," he is mistaken. Fig. 299 shows the generation of a true worm gear instead of a "hollow faced spiral gear" whatever that may mean.

In the same way, the author misapprehends the term "generating" when he applies it to a very excellent machine which forms the tooth curves by an approximating linkage system, instead of using a movement based on the geometrical qualities of the curve to be generated.

But none of these criticisms should disturb the intending purchaser, as the book is otherwise too useful to be omitted from the library of engineer or shop man. It follows the good English tradition of being solidly filled with information and being copiously illustrated with figures which are really necessary to the text. In these two respects, it may well serve as a standing rebuke to the padded and carelessly collected product of the typical American technical writer.

The last literary work of the late George Earl Church, M. Am. Soc. C. E., famous as the engineer and promoter of the first Madeira & Mamoré Ry. through the jungles at the head waters of the Amazon River, was a remarkable and valuable contribution to the ethnology of the ancient peoples of South America, which has just been published in London, by Chapman & Hall, Ltd., under the title of "Aborigines of South America." The work was unfinished at the time of Col. Church's death, Jan. 4, 1910, but the uncompleted manuscript was given into the hands of a co-worker and personal friend, Sir Clements Markham, who has edited the volume.

Col. Church had a most remarkable and interesting career as an engineer in the wilds of South America, begun in 1857 as Chief Engineer of a railway project in Argentine Republic. He was universally acknowledged to have had a wider and more complete knowledge of the history, geography and resources of South America than any other authority. Col. Church is said to have been the only man not an English subject to be admitted to a seat in the council of the Royal Geographical Society, of which he was also Vice-President for four years.

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Mechanism

Reviewed by JOHN J. FLATHER*

A TEXTBOOK OF PURE MECHANISM—By Frederick H. Sibley, Associate Professor of Mechanical Engineering, University of Kansas. New York: Henry Holt & Co. Cloth, 6x9 in.; pp. ix + 285; 266 illustrations. $3, net.

In this book the author discusses the usual topics common to works on mechanism. It would be difficult to present any better treatment of this subject than is now found in the many excellent books available, nor would one expect to find much that was original either in material or in method of discussion in any new presentation of the subject.

However, in the book under review, the author has introduced some new features, notable among which is his classification based on the method of transmitting motion, instead of on the more familiar method of making contact—i.e., point, line or surface. In that portion of the work devoted to cams an interesting method of solution is given, but the treatment of this subject is all too brief. In fact, the author's praiseworthy desire to present the subject "as briefly as possible without a sacrifice of clearness," as noted in the preface, has resulted in a lack of thoroughness in the discussion of a number of topics.

The book is divided into 12 chapters in which the following subjects are discussed: Pure mechanism; the analysis and transmission of motion; link connections and intermittent motion by linkwork; wrapping connectors; trains of mechanism; transmission of motion by rolling; rolling and sliding contact as found in cams; gearing, spur, bevel, chain gears and helical or spiral gears.

A desirable feature of the book is the large number of practical problems which accompany the text. The nature of many of the problems, and the method of treatment suggested by the text, removes them from the sphere of pure mechanism. Although the introduction of such problems is commendable, the present reviewer wonders if a different title for the book would not have been better.

It is to be regretted that the author has departed from well established terminology in certain cases, as, for instance, by the introduction of the word, "instant center," for instantaneous center. It is true the former is briefer, but long established custom lends its weight of authority for "instantaneous." The writer also regrets to see the introduction of three definitions for the pitch of gear teeth. Surely "circular" and "diametral" pitch are sufficiently definite and practical. The introduction of "diameter" pitch in addition to diametral pitch merely causes confusion in the mind of the average student.

The chapters on gearing give an admirable presentation of the subject which is augmented by the excellence and number of illustrative examples and diagrams. The work on bevel and spiral gears is also exceptionally good.

A few typographical errors are noted, as might be expected in a first edition. Some of the diagrams which accompany the text could be improved upon, as, for instance, the figure which represents Watt's approximate straight-line motion, in which the diagram does not agree with the relations of the arms. However, these are matters of minor detail which do not materially affect the book.

The value of the work as a textbook is increased materially by its superior typography.

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Cyanidation

Reviewed by F. W. TRAPHAGEN†

DETAILS OF CYANIDE PRACTICE—By Herbert A. Megraw, M. Am. Inst. M. E., Member of Editorial Staff, "Engineering and Mining Journal"; author of "Practical Data for the Cyanide Plant." New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. vii + 215; numerous illustrations. $2, net.

This book is a collection of articles on cyanidation which have recently appeared in the "Engineering and Mining Journal." Mr. Megraw, footloose, largely because of unsettled conditions in Mexico, was selected by the "Journal" to visit

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and describe the various successful cyanide mills in North America. No one is better able to do this work than Mr. Megraw and he has done it very well. He has presented not only accurate and detailed descriptions of mills and practices but has also given us, in many cases, a philosophical discussion of the reasons for such practices.

The "flow-sheets," some 20 in number, make possible at a glance an understanding of the details of operations These "flow-sheets" are great aids in descriptions of metallurgical practices and those in this book are exceptionally good.

Such a book as this must be of very great benefit to those operating mills and to those contemplating building mills, for knowledge of successful practice at other plants has its effects in modifying one's own practice. The cost data so fully given will enable the cyanide man to closely compare his costs with those at other plants. Altogether the book cannot fail to be of great value in the field of cyanidation.

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Designing the Sewers of Naunhof, Germany

Reviewed by EMIL KUICHLING*

DER ENTWURF DER KANALISATION FUR NAUNHOF BEI LEIPZIG—Von Dr.-Ing. Theodor Heyd, of Darmstadt. [Reprinted from "Der Stadtische Tiefbau," Jahrgang 1913, No. 20.] Karlsruhe, Germany: Fachpresse, Verlagsgesellschaft m.b.H., Markgrafenstr. 46. Paper; 8x12 in.; pp. 13; 10 folding drawings.

This paper is of much interest, as it represents the present practice of German engineers in designing a system of sewerage for a comparatively small community. The village of Naunhof is located in an extensive plain about 10 miles east of Leipsic, and had in 1912 a steadily growing population of 3580. It has an area of about 325 acres, the western part being traversed by a brook named The Parthe, which carries little or no water in dry weather. The topography and municipal development are such that a separate system of sewers is considered advantageous for 81 acres adjacent to the brook, whereas for the remaining 244 acres a combined system is deemed expedient. It is expected that the area will easily accommodate a future population of from 8600 to 9600, which will produce sewage at the average rate of 26.4 U. S. gal. (100 liters) per head per day, the maximum rate of discharge during the hour of greatest water consumption being assumed at 2.25 times the average rate.

The sewage is to be treated by sedimentation tanks and sprinkling filters at a plant adjacent to the brook in the northwest corner of the area, and in times of heavy rainfall the surplus flow of the combined system in excess of 10 times the dry-weather flow, is to be discharged into the brook by two storm-water outlets. No details of the contemplated treatment are given in the paper. Rainfall was measured during four years, 1908-1911 inclusive, at the site of the plant and two other stations in the vicinity, and it appears from the data that in this period the heaviest precipitation lasted 30 minutes at the rate of 1.47 in. per hour. For rains of both shorter and longer duration, the intensities were less, the largest ones being 0.95, 0.58, 0.45 and 0.38 in. per hour during respectively 80, 95, 130 and 215 minutes. Presumably these rates are averages during the periods of time mentioned. It was assumed that somewhat heavier storms might occur, and by taking the number of rains into account, the following intensities were adopted to represent what happens once a year on the average: 1.63 in. per hour during 5 minutes, 1.30 during 10 min., 1.06 during 15 min., 0.88 during 20 min., and 0.74 during 25 min.

The manner in which these figures are to be applied in computing the runoff and the diameter of the sewer is not clearly set forth. From the map it is found that the length of the longest line of sewerage above the first storm-water outlet in the combined system is about 6100 ft., and when flowing full or half-full the average velocity therein is about 2.9 ft. per sec., so that the time of flow through said length is about 35 minutes. Near the said outlet the maximum capacity of the main combined sewer is 39.2 cu.ft. per sec., which represents the storm water and sewage from an area of about 183 acres, of which at least 17% is regarded as densely populated, and the whole as discharging about 30% of the rainfall; hence provision seems to be made for a rain intensity of not more than 0.71 in. per hour lasting about 35 or 40 minutes, whereas the data indicate that a precipitation of 1.47 in. per hour lasting for 30 minutes was actually recorded in the four years of observation. It appears, therefore, that the main sewer will become seriously surcharged in the future when the assumed conditions of [illegible]face are realized.

The assumptions are that roof surfaces will [illegible]scharge 90% of the rainfall, street surfaces, 50%, and the [illegible]maining yard and garden surfaces, 10%; also that the de[illegible] popu-lated districts have 24% roof surface, 23% street [illegible]face and 53% yard and garden surface, while the sparsely [illegible]opulated districts have respectively 15, 16 and 69% of such [illegible]surfaces. These figures correspond to averages of 38.4% r[illegible] off from the densely populated territory, and 28.4% runoff [illegible]om the sparsely populated territory. It is also assumed [illegible]t in the future the 244 acres of the combined system will have 43 acres of densely populated and 201 acres of spar[illegible]ly popu-lated territory, thus making a resultant runoff of 30[illegible]% when the rain lasts long enough at uniform intensity to allow all portions of the area to contribute to the discharge of the stearm-water outlet. If, however, the duration of the rainfall is less, the discharge at this outlet will be modified by both the intensity of the precipitation and the character and location of the tributary surfaces. This important subject is treated much too briefly by the author to enable a reader to check his computations.

It may be remarked in this connection that few measurements of the actual rainfall and runoff from different classes of urban territory seem to have been published by German municipal engineers, although they have written much about the matter in recent years. The available data from all sources need extensive amplification, and it is to be hoped that reliable new observations will soon be forthcoming. This remark is prompted by the foregoing assumption that only 50% of the rainfall will run off from modern street surfaces, as the present tendency is to make them smooth and impervious.

The computation for the discharge of sewage is based on the abbreviated Kutter formula,

$$v = \left(\frac{100\sqrt{r}}{0.35 + \sqrt{r}}\right)\sqrt{rs}$$

for measures in meters, which is equivalent to

$$v = \left(\frac{181.1\sqrt{r}}{0.6338 + \sqrt{r}}\right)\sqrt{rs}$$

for measures in feet, with a factor of roughness $n = 0.0135$ and a slope of $s = 1/1905$ in the full Kutter formula for the coefficient c in $v = c\sqrt{rs}$; and if a different value of n is to be used, the abbreviated formula becomes

$$v = \left(\frac{181.1\sqrt{r}}{47 \cdot n + \sqrt{r}}\right)\sqrt{rs}$$

for measures in feet. No comment on this formula is necessary, except that after the sewers become old the value of n will probably increase to 0.015 or even somewhat more.

The diameter of the sewers ranges from 9.84 to 51.18 in., and the grades from $1/800$ to $1/1200$. They are to be of stoneware up to 20 in., and of concrete and brick for the larger sizes. Manholes are to be not more than 262 ft. apart, with intermediate lamp-holes at intervals of about 100 ft. The minimum depth of covering over the sewers is to be 7.22 ft. Details of manholes, junctions and inlets are shown in Plates 8 and 9, while Plates 7 and 10 exhibit the method used for computing runoff in the territory of the combined system. Six additional sheets of tabular matter show in detail the computations for the size and capacity of the sewer in every street.

The author is the editor of "Der Städtische Tiefbau," and is also a well known writer on sanitary engineering. He has recently published a valuable compilation of drawings relating to the design of sewers and their appurtenances, and hence the paper under consideration can fairly be regarded as representing present German practice in sewerage.

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THE MAINTENANCE OF FORESHORES—By Ernest Latham, A. M. Inst. C. E., A. M. Inst. Mech. E. With contributions by Col. R. E. B. Crompton, M. Inst. C. E., and A. E. Carey, M. Inst. C. E. London: Crosby Lockwood & Son. Cloth; 5x8 in.; pp. 84. 2 Shillings, net.

The protection of the shores of the ocean and of the great lakes against the ravages of wind and wave has not been a matter of very great concern to American engineers, partly because of the mildness of coast erosion in this country as compared with the severe sea-action in Europe, and partly because the shores which have suffered have not been of very great economic importance. The growth of the country, particularly the growth of seaside resorts, has of late years made the subject of more importance to American engineers and any systematic study which they now may make requires extensive drafts on European experience.

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The little book noted above is a very good start for such a study. It is brief, too brief to be more than an outline of the subject, and it suffers from an entire absence of illustrations, but its brevity is at least a recommendation for its rôle as an introduction to a subject. The chapters which will be of use are entitled, Classification of Coast Erosion, Protection of Low-Lying Land, Drainage of Low-Lying Lands, Protection of High Lands.

Dr. Houston's Water-Supply Experiences and Views

Reviewed by GEORGE W. FULLER*

STUDIES IN WATER SUPPLY—By A. C. Houston, Director of Water Examination, Metropolitan Water Board, London. New York: The Macmillan Co. London: Macmillan & Co., Ltd. [Macmillan's Science Monographs.] Cloth; 6x9 in.; pp. xii + 203; 43 text illustrations. $1.60, 5 shillings, net.

Any communication from the pen of Dr. Houston must be a welcome one. His wide experience and scholarly attainments are happily reflected in his writings.

This little volume or "monograph" contains a number of personal observations and experiences of the author in water-supply, particularly the water-supply to the City of London.

Chapter I considers mainly the quality of the water of the Thames and the Lee, and it is to be noted that the Thames raw water is by no means as polluted as it is generally considered to be.

In Chapter II Dr. Houston records the results of his researches tending to justify rivers as sources of water-supply. He speaks first of the streptococous test which he considers of value in indicating whether or not a water has been in contact with fecal matter, and records his laboratory tests. Then he speaks of pathogenic bacteria and refers in particular to the Gaertner's bacillus (B. enteritidis) and the typhoid bacillus. He refers to such searches having, until recently, been regarded as almost lost labor, but adds:

> Of late years, however, improvements in technic and methods have altered the whole complexion of affairs, and it is now possible, although still a difficult and laborious task, to isolate the typhoid bacillus when present in only small numbers, from a water, even when that water is swarming with other bacteria.

An account is given of his searches for pathogenic bacteria in natural raw waters and in waters artificially infected.

Chapter III considers the question of abstraction of water from the river and discusses favorable times to draw the water, as related to turbidity and color, when permitted by storage reservoirs to make the withdrawal intermittent.

Chapter IV deals with supplementary processes of water purification by mechanical filters with and without a coagulant. Very successful results are quoted for the River Ouse at York, where a bacterial efficiency of 86.27% is obtained without coagulant. Dr. Houston's experiences with coagulation indicate lack of appreciation of the effectual results achieved in this country by this method at hundreds of plants.

In Chapter V sterilization is considered. It is brought out that hypochlorite of soda was successfully used by the author for the city of Lincoln for a time in 1905. This experience, of short duration and under emergency conditions, is of historical importance, as it occurred several years before sterilization by hypochlorite was adopted for regular systematic use on the water-supply for Jersey City in 1908. The excess-lime method is fully treated. This consists of overdoing with quicklime some portion of the water to a point of germicidal action, and mixing this overdosed water with another portion purified by storage alone or some other means than by lime.

Storage, of which the author is an ardent advocate, is exploited in Chapter VI. Many valuable data are here presented. Recorded tests show the limited period of life of pathogenic bacilli in water. It appears that at temperatures of 18° C. some uncultivated typhoid bacilli may live three weeks, but at a winter temperature of 5° C. some may live six weeks.

Having in mind the difficulty of being assured of a full three to six weeks retention at all times, even in a storage reservoir of perhaps ten times that capacity, the economic advantages of storage as a substitute for filtration are far less marked than would appear at first glance.

The author's views regarding the relation of public water-supply to disease are next given. Proper purification of water is considered essential as a safeguard against epidemics of disease. The treatment of non-epidemic or endemic typhoid is particularly interesting and instructive. It is based in a large measure upon American data, but the viewpoint by no means coincides with that expressed by various epidemiologists in this country. He states:

> It is one thing to recognize the danger of epidemics being caused by impure water, and quite another to associate the non-epidemic prevalence of typhoid fever with water-supply as a factor constantly in operation, and of direct causative significance.

The so called Hazen theorem as to the influence of water purification upon the general death rate does not appeal to him as convincing, on present evidence. He moreover believes that further data should be secured to show how high is the "normal" typhoid death rate which is assumed to be of non-water origin and caused by such agencies as shellfish, milk, flies, etc. The author recognizes that conclusive evidence later to be deduced may modify his existing views which he recites as follows:

> . . . . . but he does venture to express the opinion that the evidence brought forward in favor of the direct causative relationship between the quality of water supplies and the degree of incidence of endemic typhoid fever is not always wholly convincing.

Chapter VIII treats of the financial value of a pure water-supply in a manner more or less resembling the views of Prof. Whipple, although not necessarily indorsing all of them.

The last three chapters in the book deal with methods of bacteriological procedure. To the laboratory man they are of special value as representing the views of one of the most experienced workers in this line. His laboratory practice is carefully considered and applied in a systematic and comprehensive manner in the interests of the Metropolitan Water Board of London.

The material in this book is presented in an attractive way; much of it is new and all of it is valuable. Altogether it is a very satisfactory addition to the library of those who are interested in the quality of public water-supplies.

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NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

AMERICAN WATER WORKS ASSOCIATION—Proceedings of Annual Convention, Minneapolis, Minn., June 23-27, 1913. Troy, N. Y.: J. M. Diven, Secretary. Cloth; 6x9 in.; pp. 751; illustrated.

BAU UND BERECHUNG GEWÖLBTER BRÜCKEN UND IHRER LEHRGERÜSTE; Drei Beispiele von der badischen Murgtalbahn—Von Dr.-Ing. Ernst Gaber, Gr. Bauinspektor. Berlin; Julius Springer. Paper; 8x11 in.; pp. viii + 108; 56 text figures. 6 Marks.

BAU, UNTERHALTUNG UND VERTEIDIGUNG DER FLUSS-DEICHE—Von Ehlers, Geheimer Baurat, Professor an der Technischen Hochschule Danzig. Berlin: Wilhelm Ernst & Sohn. Paper; 7x10 in.; pp. 54; 54 illustrations. 3.20 Marks.

BRITISH COLUMBIA DEPARTMENT OF LANDS—Report of the Water Rights Branch for 1913. Victoria, B. C.: Department of Lands. Paper; 7x10 in.; pp. 194; illustrated.

BRITISH RAILWAYS; A Financial and Commercial Survey—By W. R. Lawson, Chairman of the Railway Shareholders' Association; author of "American Industrial Problems," "British Economics," "Modern Wars and War Taxes," etc. New York: D. Van Nostrand Co. Cloth; 5x8 in.; pp. xxxii + 320. $2, net.

CANADIAN RAILWAY, TELEPHONE AND TELEGRAPH STATISTICS For Year Ended June 30, 1913. Ottawa: Office of the Comptrolier of Statistics. Paper; 7x10 in.; pp. 187, 78 and 30, respectively.

CEMENT, CONCRETE AND BRICKS—By Alfred B. Searle, Lecturer on Brickmaking Under the Cantor Bequest; Consulting Expert in the Cement and Clay Products Industries; author of "British Clays, Shales and Sands," "The Natural History of Clay," "Modern Brickmaking," "The Clayworker's Handbook," etc. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. xi + 412; 113 illustrations. $3, net.

CHEMISTRY IN AMERICA; Chapters From the History of the Science in the United States—By Edgar F. Smith, Blanchard Professor of Chemistry, University of Pennsylvania. New York and London: D. Appleton & Co. Cloth; 5x8 in.; pp. viii + 356; illustrated. $2.50, net.

CITY PLANNING FOR NEWARK—Newark, N. J.: The City Plan Commission. Cardboard; 6x9 in.; pp. xvi + 163; 35 plates.

The work of the Commission from its appointment on June 1, 1911, to Dec. 31, 1913, is reviewed. Various recommendations relating to the improvement of the street plan, harbor, trolley system, etc., are summarized.

CLEAN WATER AND HOW TO GET IT—By Allen Hazen, M. Am. Soc. C. E. Second edition, revised and enlarged. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 5x8 in.; pp. xii + 196; illustrated. $1.50 (6½ shillings), net.

COMMISSIONERS OF THE TRANSCONTINENTAL RAILWAY—Annual Report for Fiscal Year Ended March 31, 1913. Ottawa, Canada: Paper; 7x10 in.; pp. 47.

CONSTRUCTIONS NAVALES, ACCESSORES DE COQUE—Par M. Edmond, Paris; Encyclopedia Scientific, O. Doin et Fils, Editeurs, 8 Place de l'Odeon. Cloth; 5x8 in.; pp. 300; 116 text figures. 5 Francs.

DIGEST OF THE IMPORTANT PROVISIONS OF THE WORKMEN'S COMPENSATION LAW—Albany, N. Y.: Bureau of Statistics and Information, New York State Department of Labor. Whole No. 59, Series on Workmen's Insurance No. 1. Paper; 6x9 in.; pp. 21.

EINFLUSS DER WASSERDAMPFTENSION DER LUFT AUF DAS VOLUMEN DES CEMENTMÖRTELS—Von Leopold Jesser, Wien. Charlottenburg, Germany: Cementverlag G.m.b.H., Knesebeckstrasse 74. Paper; 6x9 in.; pp. 31; illustrated. 1.50 Marks.

ENGINEERS' COSTS And Economical Workshop Production—By Dempster Smith, M. I. Mech. S., Lecturer in Mechanical Engineering, Manchester Municipal School of Technology, and Philip C. N. Pickworth, M. Sc. Tech. [The "Mechanical World" Series.] Manchester and London: Emmott & Co., Ltd. Cloth; 6x9 in.; pp. xi + 248; 32 text illustrations. 4½ Shillings, net.

FAIR VALUE FOR RATE PURPOSES—By Robert H. Whitten. [Reprinted from the "Harvard Law Review," Vol. XXVII, No. 5.] Cambridge, Mass.: The Harvard Law Review Association. Paper; 7x10 in.; pp. 17.

THE FERTILIZING VALUE OF SEWAGE AND SEWAGE SLUDGE—A Sanitary and Economic Problem—By H. W. Clark, Chemist, Massachusetts State Board of Health. [Reprinted from the Monthly Bulletin of the Board (Boston) for December, 1913.] Paper; 6x9 in.; pp. 17.

FINANCIAL STATISTICS OF CITIES HAVING A POPULATION OF OVER 30,000: 1912. Washington, D. C.: Bureau of the Census. Bulletin 118. Paper; 9x12 in.; pp. 83.

GEOLOGIC ATLAS OF THE UNITED STATES—Washington, D. C.: U. S. Geological Survey. Paper; 18x22 in.; illustrated.

Folio No. 185: Murphysboro-Herrin (Ill.)—By E. W. Shaw and T. E. Savage. Pp. 15.

Folio No. 187: Georgia-North Carolina-Tennessee—By Laurence LaForge and W. C. Phalen. Pp. 17.

Folio No. 188: Tallula-Springfield (Ill.)—By E. W. Shaw and T. E. Savage. Pp. 12.

Folio No. 189: Barnesboro-Patton (Penn.)—By Marius R. Campbell, Frederick G. Clapp and Charles Butts. Pp. 13.

Folio No. 190: Niagara (N. Y.)—By E. M. Kindle and Frank B. Taylor. Pp. 25.

GOVERNMENT OWNERSHIP OF ELECTRICAL MEANS OF COMMUNICATION—Washington, D. C. Senate Document No. 399. Paper; 9x12 in.; pp. 148.

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